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FOSSIL DIATOMS FROM THE PRIBILOF ISLANDS, BERING SEA, ALASKA

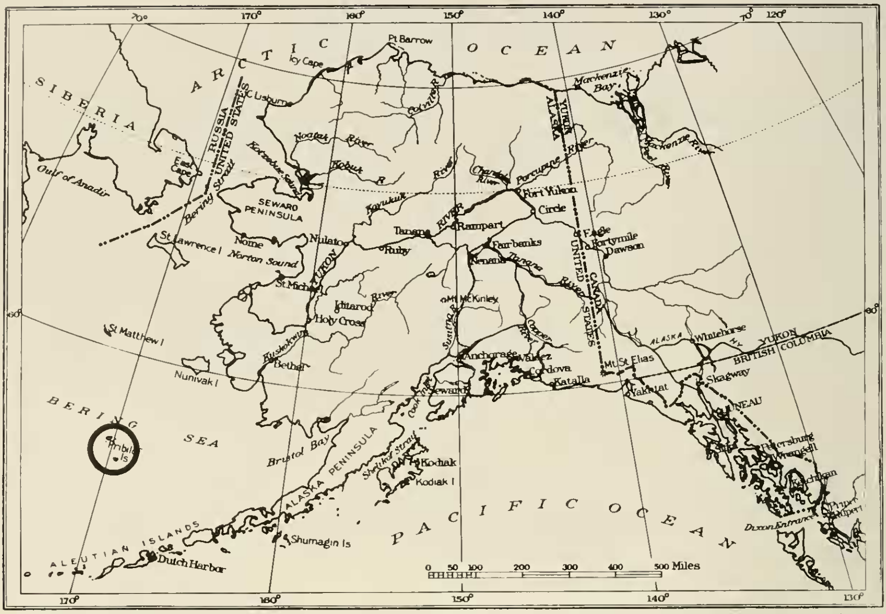
By

G Dallas Hanna

California Academy of Sciences
San Francisco, California 94118

The Pribilof group of islands is located near the center of Bering Sea, Alaska. The Aleutian Islands are about 200 miles to the south; the Alaska mainland is about an equal distance to the east; and St. Matthew Island lies about the same distance to the north. St. Paul Island is the largest of the group, about 12 miles long, and St. George is a little smaller. Otter Island is about a mile long, while Sea Lion Rock and Walrus Island are very small. All of these islands have been known since they were discovered to be the summer breeding ground of the Alaska fur seal. The climate is sub-Arctic; that is, there are no trees or woody shrubs of any kind, and there is no permafrost. Vegetation consists of a thick blanket of mosses, lichens, and grasses with a large flora of flowering plants, some of which are endemic. The plants effectively conceal some flat areas which may overlie surface sedimentary rocks. The fauna and flora have been more thoroughly explored than any other equal area in Alaska.

Except for a few favorable sea-cliff exposures, all of the visible rocks are volcanic. No terraces have been identified and no surface evidence of glacial action is apparent except for the recent report of a small ice mass which was once present on the high part of St. George Island (Hopkins and Einarsson, 1966, pp. 343–344). There are numerous craters and a great succession of lava flows. The highest point is on St. George Island and is given as 994 feet by Barth (1956, p. 102). The highest point on St. Paul is Rush Hill, 662 feet. There are a few lava caves on St. Paul, but no fumaroles or hot springs have been found on any of the islands. The surrounding sea is relatively shallow, 30 to 50 fathoms, but the depth increases rapidly to the southwest. The Bering



Map 1. Index map of Alaska showing location of Pribilof Islands in Bering Sea.

Sea ice sheet reaches the Islands once every 3 or 4 years and is a minor factor in erosion. The region is one of violent storms, one effect of which is extensive sea cliff erosion. Thus most of the shore lines are near vertical walls of more or less stratified layers of lava. Some of the former craters have been dissected so that only a landward portion remains. On St. Paul the headlands have been eroded away to such an extent that there are some extensive sand beaches between.

It was my good fortune to be stationed on the Pribilof Islands from 1913 to 1920. During this period I visited and collected extensively at the well-known locality, Black Bluff on St. Paul Island. This is a more than half dissected cinder cone at East Landing. The volcanic material evidently was extruded through some sediments because among the cinders there is an occasional block of hard gray mudstone containing abundant mollusks. These were the basis for all published reports on the paleontology of this group of islands prior to my visit. The presence of these fossils led me to make as extensive a search as possible of other sea cliffs for exposures of fossil-bearing sediments. In this I was successful to some extent as shown in the list of localities following.

It was found upon careful examination of some of the Black Bluff sedimentary blocks that large numbers of diatoms were present and that they could be obtained for study by the usual treatment with acids. This led to an examination of the newly discovered exposures and a short list of species from the one found at Tolstoi Point, St. Paul. This list has been published (Hanna, 1919, pp. 223, 224). A restudy of that material and that from all of the other diatom-bearing sediments thus far found on the islands is the basis for the present paper.

Acknowledgments

Much inspiration for the final preparation of this report was derived from consultations with F. Stearns MacNeil, David Hopkins, and the late Don K. Miller of the U.S. Geological Survey. In early work on the islands I was helped by my colleagues, the late George Haley and E. C. Johnston. And in 1960 St. Paul Island localities were visited again through the help of Howard Baltzo, Roy Hurd, and Kenneth K. Bechtel. My original interest in fossil diatoms was initiated by the study of material from these northern deposits through the encouragement of Dr. Albert Mann of Washington, D.C.

I am under deep obligation to Dr. A. L. Brigger for much assistance in the later stages of the work and especially in the making of individual mounts of specimens for museum cataloguing and storage. He also very kindly made the photographs, figures 49, 102–105. Dr. Joseph F. Burke identified the *Aulacodiscus*, one of the species being checked by Dr. Paul S. Conger. This assistance is greatly appreciated.

History of Geological Work

A general history of the Pribilof Islands is long overdue because of their being the breeding ground of Alaska fur seals, an economic asset of international significance. They are almost as well known for the vast rookeries of sea birds. Hundreds of books and papers of scientific and popular appeal have been written about the Islands, but there are scarcely a dozen which deal with the geology. Fewer yet are concerned with fossils. A late work is by Tom F. W. Barth in 1956, U.S. Geological Survey Bulletin, no. 1028-F. This contains descriptions of the various types of volcanic and igneous rocks, locations of fossil deposits, a short list of Mollusca, and an excellent bibliography.

Although the volcanic nature of the islands had been mentioned by many travellers and naturalists, the first geologist to treat the subject was J. Stanley Brown in 1892.

Dall followed in 1899 with a list of Mollusca found in the cliffs of Black Bluff, and again in 1919 with an account of those found by me at Tolstoi Point on St. Paul Island and at the Point having the same name on St. George Island. Also in 1919 I published the short note referred to above. In 1930 H. S. Washington gave an extensive account of the rocks of the Pribilofs.

A very important work concerned with the geology of the Pribilofs is that by Hopkins, MacNeil, Merklin, and Petrov (1965, pp. 1107–1114). This deals primarily with the "Quaternary correlations across Bering Strait," but some of the important information was obtained on St. Paul and St. George islands. The paper has an excellent bibliography.

This was followed by the results of additional field work included in the note on glaciation at St. George Island by Hopkins and Einarsson (1966).

Age

Some of the most common species of diatoms in these deposits are extinct in so far as available records indicate. Much work has been done on the living flora of Bering Sea and adjacent waters by Mann (1907), and several Soviet workers. The assemblages of these Pribilof deposits are scarcely comparable to those of living material. On the other hand they are similar in many ways to the species recorded by Jousé, Zabelina, and others from Sakhalin Island and Kamtschatka Pliocene. The very extensive and useful work on this area by V. S. Sheshukova-Poretskaia was received too late for profitable use in connection with the Pribilof study. It seems inescapable that the sediments which contain this assemblage of species can be no younger than Pliocene and it seems likely that they are well down in that period. Thus the diatoms confirm the age determination made by Dall from a study of the Mollusca. They do not bear out the belief of Barth and others that the age of the islands is Pleistocene.

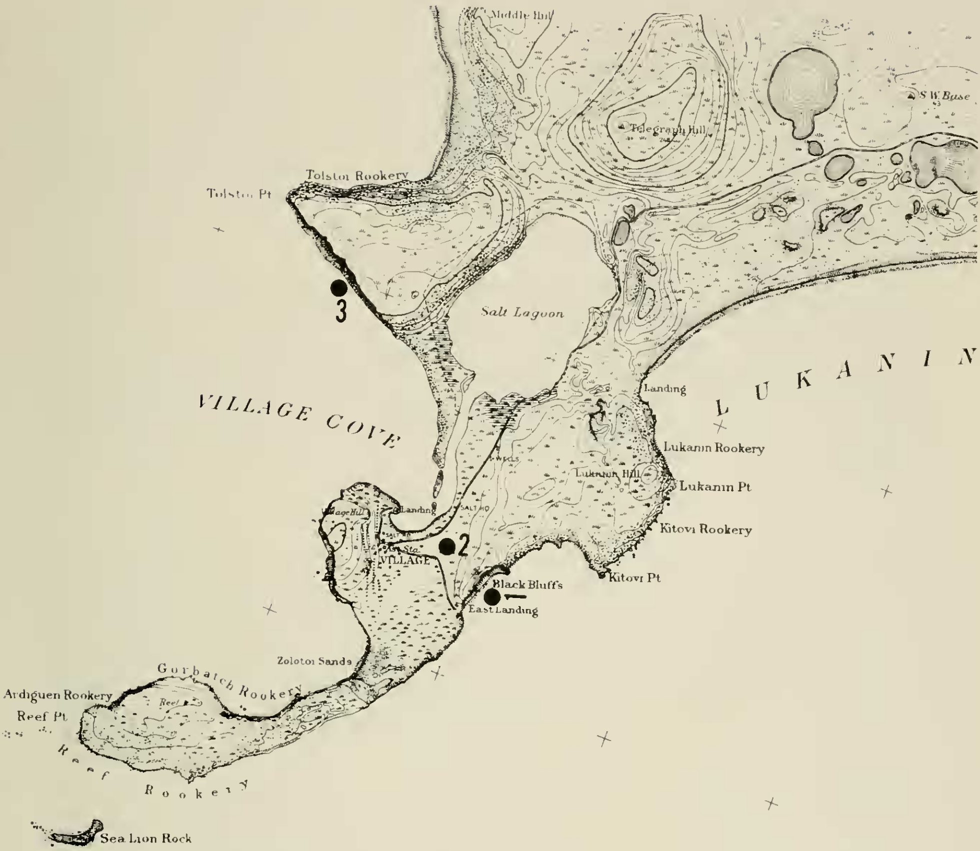
Method of Study

An attempt has been made herein to select individual diatoms representing all of the species found in the various samples studied. This seems to be the best method of preserving illustrated materials because each specimen is readily located inside a small black circle on a microscope slide. Thus it becomes a museum specimen which can be cataloged and referred to by later workers at will. The samples from Tolstoi Point, St. Paul Island were searched more thoroughly than any of the others for individual mounts.

In addition to these, several strewn slides were made from each sample cleaned. These were scanned with mechanical stage and served in compiling the lists of species from each of the samples.

As for the drill cuttings from Navy water well no. 2, long experience in the study of such samples from wells drilled for oil has indicated that the depths recorded for such cuttings cannot be relied upon exactly. There is bound to be some mixing due to slumping or other causes. Also, surface waters are often used in various ways in the drilling operations so that there is probability of mixing of freshwater living diatoms with the fossil forms. In the case of the present study, the few freshwater forms found have not been listed.

In spite of these difficulties pertaining to the use of cuttings from a well drilled with cable tools, it is believed that the samples serve a useful purpose. The most obvious, of course, is that they show sediments extending to 400 feet below sea level at St. Paul Island village, a condition which could hardly have been expected from surface geology.



MAP 2. Southwest end of St. Paul Island showing locations of the three most important localities for fossil diatoms.

COLLECTING LOCALITIES

The Pribilof Island collecting localities recorded in the register of the California Academy of Sciences are as follows:

715 Tolstoi Point, St. George Island, Alaska. Edward C. Johnston, collector, 1920.

717 Tolstoi Point, St. Paul Island, Alaska. G Dallas Hanna, collector, 1920.

1233 Black Bluff, St. Paul Island, Alaska. G Dallas Hanna, collector, 1920.

1322 Navy water well no. 2. Samples of cuttings down to 400 feet below sea level. A. Christofferson, collector, 1921.

36829 Tolstoi Point, St. Paul Island, Alaska. G Dallas Hanna, Kenneth Bechtel, and Howard Baltzo, collectors, 1960.

36830 Zapadni Point, St. Paul Island, Alaska. G Dallas Hanna, Kenneth Bechtel, and Howard Baltzo, collectors, 1960.
36832 Black Bluff, St. Paul Island, Alaska. G Dallas Hanna, Kenneth Bechtel, and Howard Baltzo, collectors, 1960.
37724 Tolstoi Point, St. Paul Island, Alaska. G Dallas Hanna, collector, 1916.
37725 Garden Cove, St. George Island, Alaska. G Dallas Hanna, collector, 1917.
37726 Navy hand-dug well, St. Paul Island, Alaska. A. Christoffersen, collector, 1927.
38597 Einahnuhto Bluffs, St. Paul Island, Alaska. Diatoms from a boulder in gravel which contains fossil shells. David Hopkins, collector, 1962.

The U.S. Geological Survey has extensive collections of fossil mollusks from both St. Paul and St. George islands. These have been collected by numerous individuals and include all such material which I was able to find up to and including 1919.

Wells

The U.S. Navy built and maintained radio stations on both St. Paul and St. George prior to World War I. From time to time they were enlarged and finally the one on St. Paul reached a critical stage because of a shortage of water. Before that, all of the water for domestic purposes was obtained from a shallow well about half a mile from the village. This location had been well selected and engineered. It was on flat land only a few feet above sea level, but adjacent to a lava flow. It was sunk just about to sea level. The water was excellent but the supply was extremely limited.

In 1918 a pump was installed at Ice House Lake under the direction of Agent and Caretaker, H. C. Fassett. A wood pipe line was laid to the village and to a tank house on top of the village hill. For the first time in the history of the island the inhabitants had an adequate supply of water without hauling or carrying it.

This lake, however, was not sufficient to supply the enlarged radio facilities. Therefore, in 1920, the Navy brought to the island a water well drilling outfit of the usual cable tool variety. The location for the first well was close to the present radio station; that is, between it and the entrance to Salt Lagoon. Scanty records indicate that total depth reached was about 160 feet when the bit was stuck. No samples have been preserved.

In 1921 a second well was drilled a little farther out toward the old village well (letter, Roy Hurd, April, 1962). Somewhat better equipment was used than on the first well. Mr. A. Christoffersen saved a suite of bailer samples for me from the various depths indicated below. The samples were collected fresh, excess water was removed, and the solids were sealed in tin cans with solder. In each case the depth was stamped in the lid of the can with steel figures. Mr.

Christoffersen was then the manager of the by-products plant located close to the well site.

Descriptions of the various samples are given below. In many of them there was well-preserved diatom material even down to the deepest one, 400 feet. Some of these samples have been cleaned by the usual technique and the species have been listed.

The Navy drilled a third well between the first and second (map 2) at a later date, but no detailed information as to depth and section has been found.

None of these three wells produced fresh water, at least not in requisite quantity for the purpose intended. Therefore, in 1927, the same organization dug a shallow well just beyond (north) the old village well. Evidentally it turned out to be useful because a windmill was installed and a pipe line was laid to the radio station. Remnants of the mill were still present in 1960. Mr. Christoffersen collected and sealed a sample for me from this well. It contains a very large assemblage of species of diatoms. These are obviously brackish water forms and belong to a much later period than those from the other wells; it has been decided not to include them in the present paper. The flora from this dug well deserves to be made the basis of a separate study.

In 1960 a completely adequate supply of excellent water for all purposes was obtained from wells on the northeast flank of Telegraph Hill.

The following are records of ditch samples recovered from water well no. 2, drilled near St. Paul Island village in 1921 by U. S. Navy, A. Christoffersen, collector. The figures indicate depth in feet.

60 Gray silty sand with many marine diatoms.
80 Black volcanic sand.
90 Black volcanic sand and scorria pebbles. A minor amount of gray silt contains marine diatoms.
130 Gray and brown sand with fragments of very hard fine grained gray sandstone.
144 Fragments of black and brown volcanic material.
164 Fine dark sand. Looks like beach sand.
177 Fine well sorted sand, not as dark as 164.
196 Fine gray well sorted sand.
198 Abundant fragments of *Spisula alaskana* and *Balanus* species in a fine, well sorted brown sand. Fragments of hard igneous pebbles up to 2 inches across, waterworn.
200 Fine gray silty sand.
206 Fine gray silty sand.
206 Fine gray sand with lumps of light gray silt and a few black waterworn pebbles. Fragments of *Spisula* species.
300 Fine gray silty sand. Abundant diatoms.
325 Fine gray silt with minor amount of fine sand.

345 Fine gray silt with some fine sand. Abundant diatoms.

400 Same as for the 345-foot depth. Stained brown from rusty container. One pebble 2 inches across. Abundant diatoms.

The following are common diatoms found in various samples from Navy well no. 2, drilled on St. Paul Island, Alaska. Locality 1322 (CAS).

Depth 60 feet

Coscinodiscus apiculatus Ehrenberg
Coscinodiscus lineatus Ehrenberg
Coscinodiscus undulosus Mann
Cosmiodiscus insignis Jousé
Rhaphoneis amphiceros Ehrenberg
Thalassionema nitzschoides Grunow

Depth 80 feet

Arachnoidiscus ehrenbergi Bailey
Coscinodiscus marginatus Ehrenberg
Coscinodiscus pustulatus Mann
Coscinodiscus radiatus Ehrenberg
Cosmiodiscus insignis Jousé

Depth 90 feet

Actinoptychus senarius (Ehrenberg)
Arachnoidiscus ehrenbergii Bailey
Coscinodiscus apiculatus Ehrenberg
Cymatotheca weissflogii (Grunow) Hendey
Coscinodiscus lineatus Ehrenberg
Coscinodiscus marginatus Ehrenberg
Coscinodiscus pustulatus Mann
Cosmiodiscus insignis Jousé
Thalassiosira punctata Jousé
Diploneis ornata Schmidt
Stephanopyxis appendiculata Ehrenberg
Trachyneis aspera (Ehrenberg)
Xanthiopyxis ovalis Lohman

Depth 105 feet

Actinoptychus senarius (Ehrenberg)
Chaetoceros species
Cocconeis, 2 species
Coscinodiscus apiculatus Ehrenberg
Cymatotheca weissflogii (Grunow) Hendey
Coscinodiscus marginatus Ehrenberg

Coscinodiscus pustulatus Mann
Coscinodiscus radiatus Ehrenberg
Thalassiosira punctata Jousé
Coscinodiscus undulosus Mann
Cosmiodiscus insignis Jousé
Dictyocha fibula Ehrenberg (Silicoflagellata)
Dictyocha speculum (Ehrenberg) (Silicoflagellata)
Ebriopsis antiqua (Schulz) (Silicoflagellata)
Melosira clavigera Grunow
Melosira sulcata Ehrenberg
Navicula lata Brebisson
Navicula, 3 species
Rhaphoneis amphiceros (Ehrenberg)
Rhizosolenia species
Xanthiopyxis ovalis Lohman

Depth 213 feet

Actinoptychus senarius (Ehrenberg)
Arachnoidiscus ehrenbergii Bailey
Chaetoceros species
Cocconeis species
Coscinodiscus apiculatus Ehrenberg
Cymatotheca weissflogii (Grunow) Hendey
Coscinodiscus marginatus Ehrenberg
Cosmiodiscus insignis Jousé
Thalassiosira punctata Jousé
Dictyocha fibula Ehrenberg (Silicoflagellata)
Dictyocha speculum (Ehrenberg) (Silicoflagellata)
Ebriopsis antiqua (Schulz) (Silicoflagellata)
Melosira clavigera Grunow
Melosira sulcata Ehrenberg
Rhaphoneis amphiceros Ehrenberg
Thalassionema nitzschoides Grunow
Xanthiopyxis species

Depth 400 feet

Actinoptychus senarius (Ehrenberg)
Cymatotheca weissflogii (Grunow) Hendey
Coscinodiscus marginatus Ehrenberg
Cosmiodiscus insignis Jousé
Coscinodiscus pustulosus Mann
Coscinodiscus radiatus Ehrenberg
Thalassiosira punctata Jousé

Dictyocha fibula Ehrenberg (Silicoflagellata)
Dictyocha speculum Ehrenberg (Silicoflagellata)
Ebriopsis antiqua (Schulz) (Silicoflagellata)
Melosira clavigera Grunow
Melosira sulcata Ehrenberg
Stephanopyxis appendiculata Ehrenberg
Thalassionema nitzschoides Grunow
Xanthiopyxis ovalis Lohman

Einahnuhto Bluffs, St. Paul Island
Locality 38479 (CAS)

A series of marine clastic sediments is exposed under volcanic rocks along the northeast shore of St. Paul Island. This exposure was studied in some detail by Dr. David Hopkins and associates of the U.S. Geological Survey in 1962 and among other things he collected a fine grained well cemented calcareous siltstone boulder. This contained a few mollusks and through his permission an examination of it was made for siliceous fossils. The material broke down readily in the usual treatment of such rocks with acids and was found to contain an abundance of diatoms. In three nights spent searching slides, the following species were picked out and identified:

Actinoptychus senarius (Ehrenberg)
Cymatotheca weissflogii (Grunow) Hendey
Coscinodiscus marginatus Ehrenberg
Cosmiodiscus insignis Jousé
Coscinodiscus pustulatus Mann
Coscinodiscus radiatus Ehrenberg
Thalosiosira punctata Jousé
Coscinodiscus undulosus Mann
Melosira clavigera Grunow
Melosira sulcata Ehrenberg
Stephanopyxis appendiculata Ehrenberg

The first four listed species are by far the most abundant. They are also abundant at Black Bluff, Tolstoi Point, and in the material from Navy Well no. 2 samples at various depths. All of the other species are likewise found in the same deposits which strongly indicate that all are of approximately the same age. In addition to the diatoms found in the Einahnuhto Bluffs sample, the silicoflagellates *Ebriopsis antiqua* and *Dictyocha* were present.

Zapadni Point, St. Paul Island
Locality 36830 (CAS)

I first saw the sediments at this locality in 1916 but did not find any fossils. In 1960 I visited it again in company with K. K. Bechtel, Howard Baltzo, and

Margaret M. Hanna. In the gray silty ash there is a small proportion of fossil diatoms. The species are the same as those found in other Pribilof Island localities.

A description of the outcrop is as follows: A fault, upthrown along the west side of Antone Lake, has produced a steep talus slope of heavy blocks of volcanic rock. This material is also exposed on the sea cliff just to the west of the lake and is followed by 20 feet of gray fissile shale with a 1-inch layer of pebbles near the bottom. This shale is underlain by a heavy conglomerate with boulders of volcanic material up to 6 inches in diameter. Two small pebbles of greenstone were found in the conglomerate. Below this the only visible remaining material was heavy black and red scorria with blocks of basalt. The entire section dips to the east 65 degrees.

The list of species found at Zapadni Point, St. Paul Island, locality 36830 (CAS), consists of the following:

Actinoptychus senarius (Ehrenberg)
Cymatotheca weissflogii (Grunow) Hendey
Coscinodiscus marginatus Ehrenberg
Coscinodiscus insignis Jousé
Coscinodiscus pustulatus Mann
Coscinodiscus radiatus Ehrenberg
Thalossiosira punctata Jousé
Coscinodiscus undulosus Mann
Dictyocha fibula Ehrenberg (Silicoflagellata)
Ebriopsis antiqua (Schulz) (Silicoflagellata)
Melosira clavigera Grunow
Melosira sulcata Ehrenberg
Stephanopyxis appendiculata Ehrenberg
Thalassionema nitzschoides Grunow

Exposure at Tolstoi Point, St. Paul Island

The exposure of sediments is perhaps best seen from the base of Lagoon Reef. It starts along the shore about ½ mile from there and lies below 150 feet or more of basaltic cliffs. It extends down below sea level an unknown distance. The outcrop extends northward about ½ mile and the maximum exposed thickness is estimated to be 70 feet. The strata are nearly horizontal for the most part, although there is a slight dip both north and south at the ends of the outcrop. Thus the exposure is an anticline but it is faulted near the center. To the south of the fault the sediments are brown sandstones, friable to firmly cemented, containing abundant fossils and interspersed layers of volcanic pebbles. Most of the fossils are bivalve shells belonging to *Astarte*. One layer of gray sandy shale is very fossiliferous and may contain diatoms. North of the fault and extending to the end of the exposure there is very fine gray shale also about 70 feet thick above sea level. This contains abundant fossil diatoms. Both the sands south of the fault and the shale north of it are overlain by nearly horizontally bedded basalt. Therefore, it is obvious that the fault is pre-volcanic. However, a crevice in the vertical cliff at that point indicates some horizontal movement on the fault after the basalt was deposited. In my earlier work I found the fine gray diatom-bearing shale only at extreme low tide. This area is now obscured by large blocks of talus basalt which have fallen from the cliff above.

Since most of the species shown on the following plates are from this locality, it seems unnecessary to list them separately. It is obvious from comparing the various lists that there is no difference in the diatom flora of any age significance among the several localities.

BLACK BLUFF, ST. PAUL ISLAND

Locality 1233 (CAS)

The following species were taken at this locality:

Actinoptychus senarius (Ehrenberg
Coscinodiscus apiculatus Ehrenberg
Cymatotheca weissflogii (Grunow) Hendey
Coscinodiscus marginatus Ehrenberg
Cosmiodiscus insignis Jousé
Coscinodiscus pustulatus Mann
Coscinodiscus radiatus Ehrenberg
Coscinodiscus undulosus Mann
Dictyocha fibula Ehrenberg (Silicoflagellata)
Distephanus speculum (Ehrenberg) (Silicoflagellata)
Melosira clavigera Grunow

ST. GEORGE ISLAND

Locality 37725 (CAS)

Seven species were taken here:

Thalassiosira punctata Jousé
Coscinodiscus marginatus Ehrenberg
Cosmiodiscus insignis Jousé
Coscinodiscus pustulatus Mann
(The above four species were very abundant)
Coscinodiscus radiatus Ehrenberg
Rhaphoneis amphiceros Ehrenberg
Stephanopyxis apendiculata Ehrenberg

SPECIES FOUND ON PRIBILOF ISLANDS

Actinoptychus splendens (Shadbolt).

(Figures 25, 26, 28, 40, 44.)

Actinophaenia splendens (Shadbolt) *in* Brightwell, Quart. Journn. Micr. Sci., vol. 8, 1860, p. 94, pl. 6, fig. 18.

Actinoptychus splendens (Shadbolt), Ralfs *in* Pritchard, Hist. Infus. ed. 4, 1861, p. 840. Schmidt, Atlas Diat., pl. 153, 1890, figs. 3, 16–17. Wolle, Diat. N. Amer., 1894, pl. 92, figs. 9–12.

Actinoptychus solisi Hanna and Grant, Proc. Calif. Acad. Sci., 4th ser., vol. 15, no. 2, 1926, p. 123, pl. 12, figs. 1–3. Maria Madre Island, Mexico.

The specimens found at Tolstoi Point and in Navy well no. 2 both on St. Paul Island, Alaska, do not differ in any constant character known to me from material customarily assigned to *A. splendens* from Tertiary deposits in California and elsewhere. It would seem better to consider the species to be one of high variability rather than to try to fit each specimen to one of a multitude of named and unnamed forms. Figure 28 approaches the variation which at one time was given the genus name *Debya*.

Actinoptychus senarius (Ehrenberg).

(Figures 38, 39, 45, 76.)

Actinocyclus senarius Ehrenberg, Infusionsthierchen, 1838, p. 172, pl. 21, fig. 6.

Actinoptychus senarius (Ehrenberg), Abh. Akad. Wiss. Berlin., 1841 [1843], p. 400, pl. 1, fig. 21. Hendey, Discovery Reports, vol. 16, 1937, p. 271.

Actinocyclus undulatus Bailey, Amer. Journ. Sci. Arts, 1842, pl. 2, fig. 11, Richmond, Virginia.

Actinoptychus undulatus (Bailey), Hanna and Grant, Proc. Calif. Acad. Sci., 4th ser., vol. 15, 1926, p. 124, pl. 12, fig. 4. Wolle, Diat. N. Amer., 1894, pl. 92, figs. 4–6.

If any species of marine diatom may be considered to be "universally distributed," it is this representative of *Actinoptychus*. Probably those forms which lived prior to the Tertiary can be distinguished but those of the Miocene and Pliocene do not seem to differ in any way from those living at the present time. There are many variations which have received names and many more which have not. The species is very common in the Pribilof Island deposits.

Arachnoidiscus ehrenbergii Bailey.

(Figure 41.)

Arachnoidiscus ehrenbergii Bailey, Wolle, Diat. N. Amer., 1894, pl. 91, fig. 2. Brown, *Arachnoidiscus*, 1933, p. 55, pl. 4, fig. 5.

The species is reasonably common in the heavier fractions of almost every Pribilof sample. *Arachnoidiscus ornatus* was not found in any of the material. Brown's extensive study of this genus resulted in his recognition of several species and varieties of somewhat questionable utility after mild criticism of earlier authors for useless multiplication of names. However, in the study of west American fossil forms I find great difficulty, after many years of observation, in being convinced that there is any escape from allowing wide limits of variation under each of a few species names. I have not found any constant differences between Miocene and living material from western North America.

The type locality of the species appears to be Puget Sound, but it is very common along the west American coast. I have collected it from Bering Sea near St. Matthew Island as far south as Maria Madre Island, Mexico. It is also found in most of the California fossil marine diatom deposits which are Miocene or later but the specimens found in the upper Eocene were called *Arachnoidiscus indicus*, rightly or wrongly. (Hanna, 1927, p. 109.)

Arachnoidiscus indicus Ehrenberg.

(Figures 77, 80.)

Arachnoidiscus indicus Ehrenberg, Ber. Akad. Wiss., Berlin, p. 47, pl. 5, fig. 7 [after Mills], [1854, p. 165, after Mann]. Ehrenberg, Mikrogeologie, 1854, pp. 163–165, 171, pl. 36, C, fig. 34, Noncoury Island, Nicobar Islands, Fossil. Schmidt, Atlas, Diat., pl. 68, fig. 6, 1886. Brown, *Arachnoidiscus*, 1933, p. 66, pl. 5, figs. 8, 9. Nicobar Islands, Fossil.

The diatoms here identified with the above name were present but not common in the deposit at Tolstoi Point, St. Paul Island. If this identification be correct it is apparently the only record of the species having been found at other than the type locality according to N. E. Brown who made an extended study of the genus. In general, diatomists were inclined to call small specimens *A. indicus*, which were not so boldly marked as *A. ehrenbergii*, thus recording the species from a great many widely spread fossil localities. Ehrenberg's original figure is a very good drawing and our specimens, it would seem, agree sufficiently to be regarded as the same species. However, some of the drawings which others have called *A. indicus*, but Brown rejected, also seem to be sufficiently close.

The original mention of the name *Arachnoidiscus indicus* and perhaps a description, may have been during 1854 in the Berichte of the Berlin Academy, a copy of which I have not seen. Cited references do not agree.

Asteromphalus darwinii Ehrenberg.

(Figure 90.)

Asteromphalus darwinii Ehrenberg, Ber. Akad. Wiss. Berlin, 1844, pp. 198, 200, fig. 1. Pelagic "64° N. Lat., 160° W. Long." Schmidt, Atlas Diat., pl. 38, 1876, fig. 16. "Monterey," Calif. Ehrenberg, Mikrog. 1854, pl. 35A, group 21, fig. 4. Wolle, Diat. N. Amer. 1894, pl. 93, figs. 8, 9. "Monterey." [Upper Miocene.]

Asterolampra darwinii (Ehrenberg), Greville, Trans. Micr. Soc. London, vol. 8, n. s., 1860, p. 116, pl. 4, figs. 12, 13, "Monterey Stone." Schultze and Kain, Bull. Torrey Bot. Club, vol. 23, 1896, p. 498. "Santa Monica" Calif. [Malaga Cove, Los Angeles Co.]

Ehrenberg described and illustrated five species in 1844 which he included in his new genus *Asteromphalus*: *A. darwinii*, *A. hookerii*, *A. rossii*, *A. buchii*, and *A. humboldtii*. All of these appear to be one species and it is therefore logical to use the first name.

Very few specimens of this pelagic genus were found in the Pribilof material, probably in part because of their fragility. The one photographed seems to be close to *A. darwinii* as illustrated by Greville. It is characterized especially by the few divisions and the structure of the division lines in the central area.

This species was selected by Boyer, (1927, p. 72.) as the genotype of *Asteromphalus*. It, and many other species of the group, have been shifted back and forth by diatomists between *Asterolampra* and *Asteromphalus*. The chief difference used to separate the two genera is the presence of one slim radial bar in *Asteromphalus*.

Aulacodiscus laxus (Mann).

(Figures 102, 103, 104.)

Tripodiscus laxus MANN, Cont. U. S. Nat. Herb., vol. 10, pt. 5, 1907, p. 280, pl. 54, fig. 3. "Station 4029 (U.S.S. *Albatross*), Bering Sea, 913 fms."

Long search of the heavier fractions of a large sample of material from Tolstoi Point, St. Paul Island by Dr. A. L. Brigger, resulted in the finding of a very few specimens of this rare species. It was submitted by Dr. Brigger to Dr. Joseph F. Burke, who is engaged in a thorough study of *Aulacodiscus* and the temporary identification was due to him. In order to be certain, however, Dr. Burke submitted a specimen to Dr. Paul Conger of the Smithsonian Institution for comparison with Dr. Mann's type and the identification was confirmed by him.

Aulacodiscus tripartitus Tempère and Brun.

(Figures 46, 49, 105.)

Aulacodiscus tripartitus TEMPÈRE and BRUN, *in* Brun and Tempère, Diatomées Fossiles de Japan, Mém. Soc. Phys. D'Hist. Nat. Genève, vol. 30, no. 9, 1889, p. 21, pl. 4, fig. 3. SCHMIDT, Atlas, Diat., pl. 169, 1892, figs. 8, 9. "Japan."

No locality was cited in the original descriptions of this species. The authors compared it to *A. kilkellyanus* Greville from Barbados, *A. septus* Schmidt from Simbirsk and *A. schmidti* Witt. *Aulacodiscus kilkellyanus* appears to be the closest.

All of the specimens from Tolstoi Point, St. Paul Island, Alaska, which have been found to date have been studied by Dr. Joseph F. Burke of Staten Island Museum in connection with his review of the genus *Aulacodiscus*, and it is his opinion that they belong to the species *tripartitus*. It is a very rare diatom in this Alaska deposit and unfortunately the first one found (fig. 46) was corroded. This gave a false impression of specific characters and it was only after protracted search that additional specimens were found by Dr. A. L. Brigger which showed the true markings (figs. 49, 105).

Biddulphia aurita (Lyngbye), Brébisson and Godey.
(Figure 78.)

Diatoma aurita Lyngbye, Hydrophytologie Danicae, . . . etc., 1819, p. 182, pl. 62, fig. D. *Biddulphia aurita* (Lyngbye), Brébisson and Godey, Considerations sur les Diatomées . . . etc. 1838, p. 12. Schmidt, Atlas, Diat., pl. 122, 1888, fig. 6. Wolle, Diat. N. America, 1894, pl. 96, figs. 8–10.

It is probable that not all diatoms which have been given the above name actually belong to the same species. However, the nomenclature is in a state which makes it seem best to adhere to this early name until someone finds time to unravel the tangle.

Biddulphia baltzoi Hanna, new species.
(Figure 82.)

Frustule in end view more slender than in most *Biddulphia*, divided into three parts, the center one with two strong spines; end processes long and heavy, projecting slightly away from center; surface with heavy, discrete dots, finer in the central section. Length .040 mm.

Holotype no. 3639 (CAS) Dept. Geol. Type Coll., from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska.

The slender shape of this diatom and the coarseness of the surface markings set it aside from any of the other species I have encountered. There is a temptation to place it in *Hemialus* which is a genus of even more slender species and found in large part lower in the Tertiary. For the present it seems best to leave it in *Biddulphia* because that genus contains so many diverse diatoms.

The species is named for Mr. Howard Baltzo of the U. S. Fish and Wildlife Service, who made it possible to secure the 1960 collections at Tolstoi Point and elsewhere on St. Paul Island.

Biddulphia roperiana Greville.
(Figure 79.)

Biddulphia roperiana Greville, Quart. Journ. Micr. Sci., vol. 7, 1859, p. 163, pl. 8, figs. 11–13; Monterey, Calif., living on seaweeds, Calif. guano. Boyer, Proc. Acad. Nat. Sci. Philadelphia, 1900, p. 700; living on Pacific Coast; Calif. Miocene.

The Pribilof Island specimens agree fairly well with the illustrations which have been published. A similar form from the Miocene of New Jersey, (*B. cookiana* Kain and Schultze, Bull. Torrey Bot. Club, vol. 6, no. 8, 1889, p. 73, pl. 89, fig. 4) seems to be very close.

Chaetoceros didymus Ehrenberg.
(Figures 62, 97, 98.)

Chaetoceros didymus Ehrenberg, Ber. Akad. Wiss. Berlin, 1845 [1846], p. 75. Mikrog. 1854, pl. 35A, group 17, fig. 5; group 18, fig. 4. Hustedt *in* Schmidt, Atlas, Diat., pl. 323, 1920, fig. 7; pl. 326, 1920, figs. 2, 6, 7. Hustedt, Rabenhorst's Krypt. Flora, Kieselalgen, vol. 7, pt. 1, 1930, p. 688, fig. 390.

The determination of fossil *Chaetoceros* is difficult because of the dismembering of the chains in which they grow. *Chaetoceros didymus* has been recorded from many wide-spread localities, especially in northern regions and this seems to be the most reliable identification for the Pribilof Island material at present. The drawing, figure 65, has been doubtfully referred to *Chaetoceros*. Several of these objects were found in the light fractions from Tolstoi Point.

Cocconeis antiqua Tempère and Brun.
(Figure 48.)

Cocconeis antiqua Tempère and Brun *in* Brun and Tempère, Diat. Foss. Japan, 1889, p. 32, pl. 8, fig. 5. Sendai and Jedo, Japan. Kanaya, Sci. Repts. Tohoku Univ., ser. 2, Geol., vol. 30, 1959, p. 107, pl. 10, figs. 1, 2 [Reprint of Tempère and Brun] Miocene, Japan. Schmidt, Atlas, Diat., pl. 191, 1894, figs. 49–52.
Cocconeis japonica Pantocsek, Diat. Foss. Ungarns, pt. 3, pl. 42, 1893, fig. 582.

Our specimens from Tolstoi Point, St. Paul Island, are very close to the figures given by Schmidt.

Cocconeis formosa Brun.
(Figure 89.)

Cocconeis formosa Brun, Diat. Esp. Nouv. Mar. Fossiles ou Pélagique. Mém. Soc. Phys. Hist. Nat. Genève, vol. 31, pt. 2, 1891, no. 1, p. 16, pl. 18, fig. 6. Sendai, Japan, fossil. Indian Ocean. Schmidt, Atlas, Diat., 1894, pl. 193, figs. 42–47. Hokkaido and Sendai, Japan. Pantocsek, Beit. Kennt. Foss. Bac. Ungarns, 1893, pl. 32, fig. 457 [See next reference for locality distribution]. Kanaya, Sci. Repts. Tohoku Univ. ser. 2, Geol., vol. 30, 1959, p. 109, pl. 10, figs. 4, 5. [Reprint of Brun] Miocene, Japan.

This beautiful diatom does not seem to be common anywhere.

Cocconeis maxima (Grunow).
(Figure 31.)

Mastogloia maxima Grunow, Verh. Zool.-Bot. Ges., Wien, vol. 13, 1863, p. 136, pl. 4, fig. 1. "Lower valve." (Mills.)
Cocconeis lorenziana Grunow, Schmidt, Atlas, Diat., pl. 191, 1894, figs. 28–34.
Cocconeis maxima (Grunow), Peragallo, H. & M., Diat. Mar. France, pl. 3, 1897, figs. 1–4.

Very few specimens referable to *Cocconeis* were found in any of the deposits studied. The one illustrated here came from cuttings in Navy Well no. 2, at 90-foot depth. It belongs to a group of species of this genus which is very widely dispersed and has many variations. It is marine in habitat and probably was not a contaminating factor in the sample from the well.

Schmidt (1894, pl. 191, fig. 54) illustrated a specimen from Hokkaido, Japan, which agrees almost exactly with our specimen. He said that Cleve would refer it to *Cocconeis scutellum* but he would not. Upon comparison with Ehrenberg's original figure (1838, pl. 14, fig. 8), it appears that Schmidt was probably correct.

Cocconeis pribilofensis Hanna, new species.
(Figure 34.)

Valve ovate with a single row of heavy beads around the margin; through the center, where the raphe would be, there are two straight rows of beads the same size as those at the margin; these rows are interrupted near the center by the omission of various numbers of beads.

HOLOTYPE no. 3574, (CAS) Dept. Geol. Type Coll. from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Length, .0302 mm.

A reasonably thorough search of the literature has failed to disclose a described species to which this may be referred.

Coscinodiscus fimbriatus Ehrenberg.
(Figure 81.)

Coscinodiscus fimbriatus EHRENBERG. Ber. Akad. Wiss. Berlin, 1844, p. 78. EHRENBERG, Mikrog. 1854, pl. 22, fig. 2. GRUNOW, Diat. Franz Joseph Land, Denk. Math.-Natur. Cl. Kais. Akad. Wiss. Wien, vol. 48, 1884, p. 74 [22], and var. *californica*, *op. cit.* RATTRAY, Rev. *Coscinodiscus*, 1890, p. 105 [553]. HUSTEDT, Kieselalgen, vol. 7, pt. 1, 1928, p. 424, fig. 227.

It is believed that the peculiar border markings of the disk should be used to distinguish this species from others of similar size. The presence or absence of a coarse rosette of aerolae in the center is not believed to be of sufficient constancy to be relied upon. Hustedt's figure of 1928 seems to bear this distinction out. The species has been repeatedly reported from upper Miocene strata of California.

Coscinodiscus kützingii Schmidt.
(Figure 7.)

Coscinodiscus kützingii SCHMIDT, Atlas, Diat., 1878, pl. 57, figs. 17, 18. HUSTEDT, Kieselalgen, vol. 7, pt. 1, 1928, p. 398, fig. 209.

The diatom is fragile and it is difficult to find perfect specimens, although fragments are present on most strewn slides. The beading is small but scattered over the disk. There are a few heavier, irregular dots. The zone of fine border markings, together with the division of the disk into sectors, seems to set the species apart, although Hustedt remarked that it stands between *C. excentricus* and *C. rothii*.

Coscinodiscus marginatus Ehrenberg.
(Figures 1, 2.)

Coscinodiscus marginatus EHRENBERG, Abh. Akad. Wiss. Berlin, 1841 [1843], p. 142. SCHMIDT, Atlas, Diat., pl. 62, 1878, figs. 1–5, 9, 11, 12. MANN, Cont. U. S. Nat. Herb., vol. 10, pt. 5, 1907, p. 253, pl. 49, fig. 2.

This large and heavy diatom is one of the most common species in the Pribilof Island deposits. The coarse markings are arranged in no geometric order. The margin is wide and transversely marked. Secondary markings are usually present on the coarse aerolae as shown in figure 1.

Coscinodiscus oculus-iridis Ehrenberg.

(Figure 18.)

Coscinodiscus oculus iridis Ehrenberg, Abh. Akad. Wiss. Berlin, 1839, p. 147. Ehrenberg, Mikrog. 1854, pl. 18, fig. 42; pl. 19, fig. 2; pl. 21, fig. 3. Schmidt, Atlas, Diat., pl. 63, 1878, figs. 6, 7, 9. Hustedt, Kieselalgen, vol. 7, pt. 1, 1928, p. 454, fig. 252.

This large diatom is widely distributed in present seas and has a long geological record. It is common in the heavy fractions of cleaned material from St. Paul Island.

Coscinodiscus pustulatus Mann.

(Figures 12, 19–24.)

Coscinodiscus pustulatus Mann, Cont. U. S. Nat. Herb., vol. 10, pt. 5, 1907, p. 257, pl. 48, fig. 3. "Bering Sea." Hanna, Amer. Journ. Sci., vol. 48, 1919, p. 224. *Coscinodiscus* sp. Hanna, 1951, Bull. Calif. State Division of Mines 154, p. 283, figs. 2, 3, St. Paul Island, Alaska, Pliocene.

This is by far the most easily recognized diatom in all of the Pribilof deposits studied in connection with this report. The species was originally described from a depth of 1866 fathoms in Bering Sea and it is entirely possible that it came from an exposed subsurface outcrop of strata of Pliocene age. Nothing like it has been seen in any of the collections of living marine diatoms I have made in the Arctic and subarctic.

A selection of many variations has been illustrated. The two valves differ. One approaches a hemisphere; the other is roundly conical like a Korean hat. Variation in size of beads is very great. It is rare that a geometrically perfect arrangement is found.

Another similar species is *C. nano-lineatus* Mann (1925, p. 68, pl. 14, fig. 4) from the Philippine Islands. It is likewise convex, contrary to *C. lineatus* which is flat, but does not flare out laterally as does *C. pustulatus*.

Coscinodiscus radiatus Ehrenberg.

(Figures 4, 8, 17.)

Coscinodiscus radiatus Ehrenberg, Ber. Akad. Wiss. Berlin, 1839, p. 148, pl. 3, fig. 1 a–c. [From Mills.]. Ehrenberg, Mikrog., 1854, pl. 19, fig. 1. Wolle, Diat. N. Amer., 1894, pl. 81, fig. 7. Hanna and Grant, Proc. Calif. Acad. Sci., 4th ser., vol. 15, no. 2, 1926, p.142, pl. 15, fig. 12. Hustedt, Kieselalgen, vol. 7, pt. 1, 1928, p. 420, fig. 225.

The specimens illustrated are from the sediments at Tolstoi Point, St. Paul Island, locality no. 36829 (CAS). They are representative of many which were recovered in the separations of coarser species in other localities. Almost always the markings are arranged in geometrical order with rarely some slight imperfection. The center is slightly depressed. As species in *Coscinodiscus* go, this one may be considered as lacking in great variability. At least, that opinion has been formed from the study of material from this limited area. However, it will be found that many names have been given to variations of the species elsewhere. (see Mills, Index, 1933–1935).

Coscinodiscus rothi (Ehrenberg).

(Figure 36.)

Heterostephania rothii Ehrenberg, Mikrog., 1854, pl. 35A, group 13B, figs. 4, 5. *Coscinodiscus symmetricus* Greville, Schmidt, Atlas, Diat., pl. 57, 1878, figs. 25–27. *Coscinodiscus rothii* (Ehrenberg), Grunow *in* Schneider, Naturwiss. Beitr. Kennt. Kraukausländer, 1878, p. 125. Hustedt, Kieselalgen, vol. 7, pt. 1, 1928, p. 400, fig. 211.

In the deposit at Tolstoi Point, St. Paul Island, there are many small and highly variable diatoms which belong to this general group. Because of the inadequacy of many early figures, such as those on plate 57 of Schmidt's Atlas, species are difficult to separate, more so perhaps than any other part of this difficult genus.

Coscinodiscus undulosus Mann.

(Figure 3.)

Coscinodiscus undulosus Mann, Cont. U. S. Nat. Herb., vol. 10, pt. 5, 1907, p. 259, pl. 49 fig. 1.

This species was found in the first sample studied in 1916 from Tolstoi Point, St. Paul Island, and was identified by Dr. Mann among the slides I made then. He had found it in only one dredging of the U.S.S. *Albatross*, Station 3526 in Bering Sea. In later work it was found frequently in material from the Navy Well, Black Bluff, and Zapadni Point on St. Paul Island.

Cosmiodiscus insignis Jousé.

(Figures 9, 10, 11, 30, 32.)

Cosmiodiscus insignis Jousé, Diatomeae Marinae Mioceni et Plioceni ex Oriente Extreme. Notula Systematicae e Sectione Cryptoganiea Instituti Botanici Nomine V. L. Komarovii Academiae Scientiarum USSR, 1961, p. 67.

Valve strongly convex with radial rows of beads; these are heaviest toward the center but the center is usually a large hyaline area without markings or, if present, very sparingly distributed. The margin is heavy and hyaline; just inside it there is a series of slightly elongate spines or low ridges.

This species and *Coscinodiscus pustulatus* Mann are extremely abundant in all of the fossil bearing shales found on the Pribilofs, and, it would appear, they can be used as characteristic fossils for this northern horizon. The highest elevation in which the formation was found is about 50 feet above sea level, but the fact that it extends downward 400 feet shows that it is a formation of considerable magnitude. The species was described by Mrs. Jousé from lower Pliocene strata of Sachalin Island and apparently has been found living in the littoral zone of the Kamtschatka Peninsula. She compared the species to *Coscinodiscus* (*Cestodiscus*) *intersectus* Brun (1891, p. 22, pl. 20, fig. 5) from the Miocene (?) of Sendai, Japan. This seems to be a flatter diatom and with a much smaller hyaline central area, although *C. insignis* at the Pribilof localities is a highly variable species.

It is interesting to note that Mrs. Donahue has recently found this species in the Pleistocene of the Pacific Sector of the southern ocean. (Donahue, 1967, p. 135, pl. 1, figs. e, f.).

Cymatotheca weissflogii (Grunow), Hendey.
(Figures 15, 16.)

E[*uoda*] (genus novum?) *weissflogii* Grunow *in* Van Heurck, Syn. Diat. Belgique, pl. 126, 1883, fig. 13. West Africa, Bengal, China, Brazil.

Euodia weissflogii (Grunow) *in* Leuduger-Fortmorel, 1898. Diat. Mar. Côte Afrique, p. 18, pl. 3, fig. 13.

Euodia ratabouli Brun *in* Leuduger-Fortmorel, 1898. Diatomées Marines de la Côte Occidentale d'Afrique, p. 24, pl. 5, fig. 3.

Coscinodiscus asymmetricus Meister, Kieselalgen aus Asien, 1932, p. 19, pl. 4, figs. 32, 33. Belewan.

Hemidiscus weissflogi (Grunow) Hustedt, 1953. Marine littoral diatoms of Beaufort, North Carolina, Duke Univ., p. 11, pl. 1, figs. 6, 7. Found on piles in the harbor.

Cymathotheca weissflogii (Grunow) Hendey, Journ. Roy. Micr. Soc., vol. 77, 1957 [1958], p. 41, pl. 5, fig. 9. Voigt, Journ. Roy. Micr. Soc., vol. 78, nos. 3–4, 1958 [1960], p. 93, pl. 1, figs. 1, 2.

The literature indicates that this diatom is widely distributed in the southern hemisphere and especially along the west coast of Africa and the southeast coast of Asia. It is surprising to find it fairly common in the Pliocene deposits of the Pribilof Islands. The species was not widely known among diatomists until details of its structure were studied by Hendey and published in 1958. Voigt added much additional distributional information in 1960 and described a variety and an additional species, *C. minima*. The Pribilof specimens do not vary as widely in shape and sculpture as has been described for the recent collections, yet their characters are not very constant.

There is an allied species (undescribed) in Upper Miocene diatomite at Monterey, California. This one is circular in shape with the two halves in different planes as in *C. weissflogii*, but the sculpture is essentially as in many *Coscinodiscus*.

Another similar species is "*Coscinodiscus temperei*" Brun, (1889, p. 33, pl. 8, fig. 2) from "Sendai, Japan." This was illustrated again by Schmidt, (1891, pl. 163, fig. 9). Jousé recorded it from eastern USSR fossil deposits in 1959, (p. 47, pl. 2, fig. 7).

Dicladia capreola Ehrenberg.

(Figure 63.)

Dicladia capreola EHRENBERG, Mikrog. 1854, pl. 35A, group 18, figs. 5, 8. WOLLE, Diat. N. Amer. 1894, pl. 64, figs. 5–7.
Dicladia pylea HANNA AND GRANT, Proc. Calif. Acad. Sci., 4th ser., vol. 15, no. 2, 1926, p. 142, pl. 16, figs. 4, 5. Maria Madre Island, Mexico, Miocene.

Objects such as this are common in the deposit at Tolstoi Point, St. Paul Island, although in order to recover them special care needs to be taken in separating the light fraction during preparation.

Diploneis bombus Ehrenberg.

(Figure 14.)

Diploneis bombus EHRENBERG, Mikrog. 1854, pl. 19, fig. 31. SCHMIDT, Atlas, Diat., pl. 13, 1875, figs. 4–6; pl. 69, figs. 28, 29.
Navicula bombus densistriata SCHMIDT, Atlas, Diat., pl. 13, 1875, figs. 11, 12. "California."
Navicula densistriata (Schmidt), HANNA AND GRANT, Proc. Calif. Acad. Sci., 4th ser., vol. 15, no. 2, 1926, p. 150, pl. 17, figs. 8–10. "Maria Madre Island, Mexico."

Very few diatoms of this form were found in the Pribilof Island deposits. The one illustrated came from 90 feet depth in Navy Well no. 2, St. Paul Island.

Diploneis ornata Schmidt.

(Figure 13.)

Navicula ornata SCHMIDT, Atlas, Diat., pl. 69, 1881, fig. 5. "Monterey." WOLLE, Diat. N. Amer., 1894, pl. 15, fig. 20.

This particular form of *Diploneis* has a long geological range; that is, from middle Miocene to the present. It is rare in the Pliocene deposits of the Pribilof Islands, the example illustrated having come from locality no. 36829, Tolstoi Point, St. Paul Island. Material from this locality was searched more extensively than any of the others.

Dossetia temperei Azpeitia.

(Figures 59, 60.)

Dossetia temperei AZPEITIA, Asoc. Española Progreso de las Ciencias; Congreso de Zaragoza, vol. 4, sect. 4a, 1911, p. 203, pl. 9, figs. 3, 7. "Serrata de Lorca," Spain.
Xanthiopyxis lacera FORTI, Cont. Diat. XIII. Atti d. Reale Ist. Veneto di Sci. Lett. Art., vol. 72, pt. 2, 1913, p. 21 [1555], pl. 2, [12], figs. 14–18. Miocene, Italy. KOROTKEVIEZ, Species novae Diatomacearum e Neogeno Peninsulae Kamczatka, Akad. Nauk SSSR, 1964, p. 108, pl. 3, figs. 3, 4.

Diatoms of this general shape are common in the finer fractions from most marine deposits of west American Miocene and Pliocene age. There appear to be more than one species. Those found in some Pliocene deposits of California lack the marginal fringe. Azpeitia considered these diatoms to be sufficiently distinct to warrant generic separation, a decision which seems to have been well taken.

Hemidiscus cuneiformis Wallich.
(Figure 35.)

Hemidiscus cuneiformis Wallich, Trans. Micr. Sci. London, n.s., vol. 8, 1860, p. 42, pl. 2, figs. 3, 4. Hustedt, Kieselalgen, vol. 7, pt. 1, 1930, p. 904, fig. 542. Hendey, British Coastal Algae, pt. 5, Bacill. 1964, p. 94, pl. 22, fig. 9.
Hemidiscus simplicissimus Hanna and Grant, Proc. Calif. Acad. Sci., 4th ser., vol. 15, no. 2, 1926, p. 147, pl. 16, fig. 13.

This widely distributed plankton species is confined to tropical and temperate waters at present but it was common in Bering Sea at the time of deposition of the sediments on St. Paul Island. The latter are rather finely marked as compared to living forms, but this difference is so slight that it probably does not have taxonomic significance.

Hemidiscus rotundus Janisch.
(Figure 86.)

Hemidiscus rotundus Janisch, Diat. gesam. Reise der "Gazelle," 1874–1876 [1888], pl. 1, fig. 6. Hustedt *in* Schmidt, Atlas, Diat., pl. 438, 1940, fig. 1.

The report by Janisch was never actually published, although a few copies of the plates (except plates 10 and 14) were distributed to selected diatomists. The California Academy of Sciences' copy appears to be the one described in detail by Junk (1926–1936, pp. 153, 217–218). It is accompanied by a typewritten list for each plate, showing the identification of each figure by Janisch on one side and at times by Rattray or Norman on the other. In the case of *H. rotundus*, Rattray's identification was "*Coscin*: *curvatus* var. *recta* Rattr."

Hemidiscus bicurvans Barker and Meakin (1949, p. 302, pl. 38, fig. 7) from the Eocene of "Conset, Barbados" may be ancestral to *H. rotundus*. It seems to lack the marginal ocellus according to the figure.

Hercotheca inermis Mann.
(Figure 84.)

Hercotheca inermis Mann, U. S. Nat. Mus. Bull. 100, vol. 6, pt. 1, 1925, p. 82, pl. 18, figs. 1, 2. Philippine Islands, living.

The St. Paul Island specimen seems clearly to be allied with another species of this genus, viz., *H. mammalaris* Ehrenberg. The presence in the case of the Alaska specimen of two frustules attached in chain fashion is a strong argument against such objects being endocysts of some very unlike diatoms. The name *H. brevispina* Grunow has not been formally published and cannot be identified except by referring to a slide; it is strictly a *nomen nudum*. Mann offered good evidence against such objects being endocysts.

Lithodesmium undulatum Ehrenberg.

(Figure 91.)

Lithodesmium undulatum Ehrenberg, Abh. Akad. Wiss. Berlin, 1840, p. 75, pl. 4, fig. 13. Schmidt, Atlas, Diat., pl. 151, 1890, fig. 41; pl. 152, 1890, figs. 1–3.

The variation is so great in members of this pelagic genus that it seems best to refer our Pribilof Island species to the oldest name. A later genus name, *Ditylum* Bailey, seems to be a synonym.

Melosira clavigera Grunow.

(Figures 52, 54.)

Melosira clavigera Grunow *in* Schmidt, Atlas, Diat., pl. 74, 1876, figs. 13–15. "Monterey," [Calif.; Miocene.]. Grunow *in* Van Heurck, Syn. Diat. Belgique, 1882, pl. 91, figs. 1, 2. "Monterey and San Francisco," California.

This very common diatom is found in many west American fossil deposits. The radial bars vary in fineness and length somewhat but usually not enough to cause the identification to be questioned. It resembles *Melosira sol.*

Melosira sulcata (Ehrenberg).

(Figures 50, 51, 53.)

Gallionella sulcata Ehrenberg, Ber. Akad. Wiss. Berlin, 1837, p. 61. Ehrenberg, Infusionthierken, 1838, p. 170, pl. 21, fig. 5. "Oran," North Africa. Ehrenberg, Abh. Akad. Wiss. Berlin, 1840, pl. 3, fig. 5 [Reference after Kützing, 1844].

This species of *Melosira* has characteristic heavy wedge-shaped radial bars; they are highly variable, but seem always to be present. Individuals were common in all of the Pribilof deposits which were studied in detail. Figure 50, is from Einahnuhto Bluffs, and figure 51 is from Tolstoi Point, both on St. Paul Island, Alaska.

These Pribilof Island specimens resemble most *Cyclotella antiqua*, W. Smith, (1853, p. 28, pl. 5, fig. 49) as illustrated by Grunow in Van Heurck, (1882, pl. 92, fig. 1). That species, however, is very small and seems always to be found in fresh water or freshwater deposits.

Navicula semen Ehrenberg.

(Figure 96.)

Navicula semen Ehrenberg, Abh. Akad. Wiss. Berlin, 1843, pl. 1, group 2, fig. 17. Hustedt *in* Schmidt, Atlas, Diat., pl. 299, 1913, figs. 18–20.

This freshwater diatom is widely distributed in the northern hemisphere. Its presence in the marine deposit at Tolstoi Point, St. Paul Island, Alaska, is probably due to drift from rivers. The above identification of the species was suggested by Dr. Ruth Patrick from an examination of the photograph. Cleve (1894, p. 139) stated that Ehrenberg's original figure was not recognizable. Apparently the species is found living only on rare occasions although it is reported to be common in Pleistocene deposits.

Pinnularia lata (Brébisson).
(Figure 33.)

Frustulia lata BRÉBISSON, Mem. Soc. Sci. Nat. Falaise, 1838, p. 18.
Navicula lata (Brébisson), W. SMITH, Syn. Brit. Diat., vol. 1, 1853, p. 55, pl. 18, fig. 167. MANN, Cont. U. S. Nat. Herb., vol. 10, pt. 5, 1907, p. 346.

Published records indicate that this is an exceedingly widely distributed species. Many varities and forms have been named and nearly all refer to living material. Since it is strictly a freshwater species, I hesitate to include it in this report. It was found only in cuttings (ditch samples) from a depth of 90 feet in Navy Well no. 2 (locality no. 1322, CAS). It could very well have been present in surface waters used in bailing the well and it is included solely to illustrate the caution which should always be taken in the study of "ditch" or "bailer" samples.

Pinnularia ruttneri Hustedt.
(Figure 101.)

Pinnularia ruttneri HUSTEDT *in* Schmidt, Atlas, Diat., pl. 390, 1934, figs. 6–8.

The presence of scattered freshwater diatoms in marine deposits of late Tertiary and Quarternary ages is not unusual and can be attributed to material carried out to sea from rivers. This species is one which was originally found living in lakes of Sumatra and the identification was suggested by Dr. Ruth Patrick from an examination of the photograph. A similar species, widely distributed in the northern hemisphere is *P. streptoraphe* Cleve (see Hustedt, 1930, p. 337, fig. 620) which differs in some details.

Pseudopyxilla dubia (Grunow) Forti.
(Figures 66, 68.)

Pyxilla dubia GRUNOW *in* Van Heurck, Syn. Diat. Belgique, pl. 83, 1882, figs. 7, 8; pl. 83 *bis*, fig. 12 "Monterey" upper Miocene. WOLLE, Diat. N. Amer., 1894, pl. 65, fig. 24.
Pseudopyxilla dubia (Grunow), FORTI, Nuova Notarisia, vol. 20, 1909, p. 12, pl. 1, figs. 1–3.

Several simple forms such as those illustrated are common in the light fractions of Pribilof Island samples. Whether they should all be called the same or if two or more species should be recognized remains to be determined when a careful study can be made from several localities. Forti, 1909, described *P. tempereana* in the paper cited usually as "*Pÿxilla*." The illustrations do not differ greatly from *P. dubia*.

Pyxilla americana Grunow.

(Figure 61.)

Pyxilla americana GRUNOW *in* Van Heurck, Syn. Diat. Belgique, 1882, pl. 83 *bis*, figs. 1–3. WOLLE, Diat. N. Amer., 1894, pl. 65, figs. 8, 17, 18.

Objects similar to this one are common in light fractions of many preparations of fossil diatoms. Their exact nature is not known in most cases and have sometimes been considered to be "resting spore cases" of such diatoms as *Rhizosolenia*. They were found in most of the deposits on St. Paul Island, Alaska.

Rhabdonema crozieri (Ehrenberg), Grunow.

(Figure 94.)

Striatella crozieri EHRENBERG, Ber. Akad. Wiss. Berlin, 1854, pp. 524, 529. EHRENBERG, Mikrog., 1854, pl. 38A, group 23, figs. 14–16.

Rhabdonema crozierii (Ehrenberg), GRUNOW, Verh. Zool. Bot. Ges. Wien, vol. 12, 1862, p. 423. FRICKE *in* SCHMIDT, Atlas, Diat., pl. 220, 1889, figs. 4–9; pl. 221, fig. 1.

This species was first found at "Assistance Bay," Cornwallis Island, Canadian Arctic, N. Lat. 73°50′. Our specimen is slightly wider in proportion to length than Ehrenberg's original figures indicate, but this is not believed to be significant in this group of diatoms. Mills, (1934, p. 1386) suggested that *R. crozieri* was the same as *R. arcuatum* Kützing and that Ralfs' interpretation was *R. adriaticum* Kützing. Upon comparison of original illustrations neither of these interpretations seem very sound.

Rhabdonema japonicum Tempère and Brun.

(Figures 47, 92, 93, 95.)

Rhabdonema japonicum TEMPÈRE and BRUN, Mém. Soc. Phys. d'Hist. Nat. Genève, vol. 30, no. 9, 1889, p. 53, pl. 1, fig. 6. FRICKE *in* Schmidt, Atlas, Diat., pl. 230, 1899, figs. 18–21.

Fricke's excellent drawings on plates 217–221 of the Atlas show several of the named varieties of this species. They span the series from St. Paul Island, Alaska, and probably should not be considered as separate taxa. The cross bars of the species bear a single row of prominent dots and the valves are not usually curved in edge view. These characters serve to separate members of the genus from the *Entopyla-Gyphria* complex.

Rhaphoneis amphiceros Ehrenberg.

(Figures 29, 55, 56.)

Rhaphoneis amphiceros EHRENBERG, Ber. Akad. Wiss. Berlin, 1844, p. 87. EHRENBERG, Mikrog., 1854, pl. 33, group 14, fig. 22; group 15, fig. 20. WOLLE, Diat. N. Amer., 1894, pl. 37, fig. 20. HANNA AND GRANT, Proc. Calif. Acad. Sci., 4th ser., vol. 15, no. 2, 1926, p. 165, pl. 20, fig. 8. HANNA, Proc. Calif. Acad. Sci., 4th ser., vol. 20, no. 6, 1932, p. 211, pl. 15, figs. 3–5.

Most of the specimens of *Rhaphoneis amphiceros* found in the Pribilof Island deposits were the short sparsely marked forms such as those illustrated by figures

55 and 56. Many published figures show much finer markings for this species, but all of the genus are so highly variable that it is believed a measure of stability will be effected by assuming rather wide limits to variation. The diatom illustrated by figure 29 is confusing. The print looks as if two exposures had been made with the negative offset, but this is not the case. It is believed that this is a nearly typical example of *R. amphiceros* but in a much corroded condition. A somewhat similar situation was found in *Aulacodiscus tripartitus*, figure, 46.

Rhaphoneis lancettula Grunow.

(Figure 57.)

Rhaphoneis lancettula Grunow *in* Pantocsek, Beit. Kennt. Foss. Bac. Ungarns, pt. 1, 1886, p. 35, pl. 27, fig. 271 "Richmond, Petersburgh, Naparima." (Grunow.)

Rhaphoneis lancettula var. *jutlandica* Grunow, Pantocsek, Beit. Kennt. Foss. Bac. Ungarns, pt. 1, 1886, p. 35, pl. 30, fig. 321. "Mors Jutlandiae."

Raphoneis asiatica Brun, Mém. Soc. Phys. d'Hist. Nat. Genève, vol. 30, no. 9, 1889, p. 51, pl. 1, fig. 8. "Calcaire de Yédo [Japan] et dépôt d'Onianïno (Russie)."

Several excellent specimens of this greatly elongated representative of *Rhaphoneis* were found in the Pribilof Island deposits. According to the drawings, *R. asiatica* differs from the earlier-named one only by having fewer dots on the surface of the valve. The species dates back to the Eocene if Pantocsek's record may be accepted.

Rhaphoneis nitida (Gregory).

(Figure 27.)

Cocconeis nitida Gregory, Trans. Roy. Soc. Edinburgh, vol. 21, pt. 4, 1857, p. 20, pl. 1, fig. 26. Hustedt, Kieselalgen, vol. 7, pt. 2, lief. 2, p. 177, fig. 683a.

It would seem that the very coarse beads, each separated by a considerable space would make this a very easily identifiable species. This has not been the case. The name selected above is as satisfactory as any I have been able to get, but a closer match than this would be preferable.

Rhaphoneis rhombus Ehrenberg.

(Figure 83.)

Rhaphoneis rhombus Ehrenberg, Ber. Akad. Wiss. Berlin, 1844, p. 87. Ehrenberg, Mikrog., 1854, pl. 33, group 13, fig. 19 (not pl. 18, figs. 84, 85). Hanna, Proc. Calif. Acad. Sci., 4th ser., vol. 20, no. 6, 1932, p. 212. Lohman, U. S. Geol. Surv. Prof. Ppr. 189-C, 1938, p. 93.

This species was not common in any of the Pribilof Island samples studied. The last two papers cited above indicate some of the problems involved in working with this group of *Rhaphoneis*.

Stephanopyxis appendiculata Ehrenberg.

(Figures 58, 99, 100.)

Stephanopyxis appendiculata Ehrenberg, Mikrog., 1854, pl. 18, fig. 13b. Schmidt, Atlas, Diat., pl. 130, 1888, fig. 34. Wolle, Diat. N. Amer., 1894, pl. 62, figs. 12–15.

The spines are often missing on the crown of specimens found in the Pribilof Island deposits. They have probably been broken either in cleaning or in the compaction of the shale after deposition. Otherwise the species seems to be typical of many localities and with an extensive geological range. Many varietal names have been given to diatoms of this species and *S. turris*, but most of them are based upon what seem to be very slight differences. Unless such variations have some constant biological, geographical, or geological significance, it seems best to use the earliest name for the group. This is not to imply that variation per se should not be studied, because it is fundamental to all studies of biology and paleontology, especially when classification is involved.

Thalassionema nitzschoides (Grunow).
(Figure 37.)

Synedra nitzschoides GRUNOW, Verh. Zool.-Bot. Ges. Wien, vol. 12, 1862, p. 403, pl. 8, fig. 18.

This small diatom was found to be very abundant in all of the Pribilof Island deposits when the finer materials were closely examined. The only markings on the valve consist of a single row of beads around the border. Length varies considerably but in this region general shape is quite consistent. There are no cross bars or pseudoraphe, this being the main reason for recognizing the diatom as distinct from members of the genus *Synedra* in which it was originally placed.

When the genus *Thalassionema* was first proposed (Grunow in Van Heurck, 1881, pl. 43, figs. 7–10) the name was printed in very small type under the heading "*Thalassiothrix? ? nitzschoides.*" No other species was included but several "varieties" have been. Some confusion exists in the literature as to the application of the names *Thalassionema*, *Thalassiosira*, and *Thalassiothrix*. *Thalassiosira* is a monotypic genus formed by Cleve (1873, p. 6) for the species *nordenskioldii* (p. 7, pl. 1, fig. 1), from "Davis Strait," a circular diatom.

Thalassiosira punctata Jousé.
(Figures 5, 6.)

Thalassiosira punctata JOUSÉ. The main phases in the development of the flora of marine diatoms in the far eastern seas of the USSR at the end of the Tertiary, and during the Quaternary period. Akad. Nauk. SSSR. Bot. Inst., vol. 44, no. 1, 1959, pp. 44–55, pl. 4, fig. 17. JOUSÉ, Diatomeae Marinae Mioceni et Plioceni ex Oriente extremo. Notulae Systematicae e Sectione Cryptogramica, Instituti Botanici Nomine V. L. Kromarovii Academiae Scientiarum USSR, vol. 14, 1961, p. 64, pl. 1, figs. 7, 8; pl. 3, fig. 3.)

This very distinct diatom was found frequently in the earliest samples from St. Paul Island, which were studied and it is common in most of the material which has been prepared.

At first it might be suspected that this is a freak or a superposition of one diatom on another, but this is not the case. When picking out specimens from a dry strewn slide, the species is very conspicuous owing to its deep brown prismatic color. Mounted specimens were brought to Washington in 1917, and Dr. Albert Mann, who studied them at some length, was unable to assign them definitely to any known species.

Triceratium condecorum Brightwell.

(Figures 42, 88.)

Triceratium condecorum Brightwell, Quart. Journ. Micr. Sci., vol. 1, 1853, p. 250, pl. 4, fig. 12. Schmidt, Atlas, Diat., pl. 76, 1882, fig. 27. Hanna, Proc. Calif. Acad. Sci., 4th ser., vol. 20, no. 6, 1932, p. 221, pl. 17, figs. 1, 3.

It is believed that the Pribilof Island diatoms illustrated by figures 42 and 88 belong to this widely distributed species. It goes back to middle Miocene. There is considerable variation in the coarseness of the surface markings but the absence of spines or processes in the angles is a constant character.

Triceratium montereyi Brightwell.

(Figure 43.)

Triceratium montereyi Brightwell, Quart. Journ. Micr. Sci., vol. 1, 1853, p. 251, pl. 4, fig. 8. Schmidt, Atlas, Diat., pl. 150, 1890, fig. 21, [See pl. 153 for name]; pl. 159, fig. 7; pl. 165, fig. 4.

The specimens from the Pribilof Islands are very close to those found in the vicinity of Monterey, California, both living and fossil.

Triceratium validum Grunow.

(Figure 85.)

Triceratium validum Grunow *in* Schmidt, Atlas, Diat., pl. 94, 1886, fig. 5. "Santa Monica" [= Malaga Cove, Los Angeles County, California].

The diatom from Tolstoi Point, St. Paul Island differs somewhat from available figures of *T. validum*; this specimen has much more crowded surface markings. The original figure in the Atlas shows very scattered beads. In spite of this difference it seems best not to separate the Alaska form until more specimens can be made available for study. The name "*T. tripolaris*" was given to a similar form from Japan, Miocene by Tempère and Brun (1889, p. 66, pl. 6, fig. 7). It was also used by Schmidt, (1891, pl. 166, figs. 1, 2). This has crowded surface markings and a central zone where they are very scattered.

Xanthiopyxis globosa Ehrenberg.

(Figure 74.)

Xanthiopyxis globosa Ehrenberg, Ber. Akad. Wiss. Berlin, 1844, p. 273. Forti, Cont. Diat. XIII, Atti R. Inst. Veneto, Sci. Lett. Art., 1913, vol. 72, pt. 2, p. 1556 (22) pl. 12 (2), figs. 39–49. Hanna, Proc. Calif. Acad. Sci., 4th ser., vol. 20, no. 6, 1932, p. 224; pl. 18, fig. 3. Sharktooth Hill, California, Middle Miocene.

Apparently no named illustration of this common species appeared from 1844 until 1913 when Forti gave good photographs of Miocene specimens from

Italy, unless the diatom which Azpeitia (1911, p. 207, pl. 11, fig. 3.) listed as *Hercotheca? caput-medusae* Azpeitia can be the same. The spines appear on his photograph to be confined to the marginal area whereas they cover the disk in *X. globosa*. *Omphalotheca californica* Hanna, (1927, p. 117, pl. 20, figs. 6, 7; 1930, p. 192) is a much more symmetrical form. It came from upper Eocene.

There is considerable confusion among generic names which have been given to diatoms of this general form. *Xanthiopyxis* dates from 1844, (Ehrenberg, p. 264) where the name appears as a subgenus of *Pyxidicula*. Four species were included on page 273, under the names, "*alata*," "*globosa*," "*oblonga*," "*constricta*." Bailey, (1845, p. 327, pl. 4, fig. 14) illustrated one of these, "*oblonga*," and it should therefore be the genotype. It was 10 years before *Omphalotheca* appeared (Ehrenberg, 1854, p. 132, pl. 35A, IX, fig. 4) for *Omphalotheca hispida*. The species, *O. ampliata* and *O. laevis* were included in the genus, but have not been illustrated. The spines of the specimen illustrated here are long and sharply pointed. The species suggests *Liradiscus minutus* which Greville (1865, p. 47, fig. 6) recorded from Barbados, but in that one the spines are quite short.

Xanthiopyxis lohmani Hanna, new species.
(Figure 69.)

Valve a long symmetrically oval shape with a single row of low spines forming a slightly broader oval on the disk. Length .0306 mm.

Holotype no. 3609 (CAS), Dept. of Geol. Type Coll., from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska.

While this species was found rarely in the finer fractions from locality no. 36829 (CAS), it, or a closely similar species, has been noted in great abundance in deposits of Pliocene age in California, notably those exposed on Harris Grade, between Santa Maria and Lompoc, Santa Barbara County. The central ring of spines seems to be a constant character, although they are not always as regularly spaced as in the Alaska specimens.

Xanthiopyxis ovalis Lohman.
(Figures 64, 70.)

Xanthiopyxis ovalis LOHMAN, U. S. Geol. Surv. Prof. Paper 189C, 1938, p. 91, pl. 20, fig. 6; pl. 22, fig. 12.

This distinctive and not highly variable diatom was common in the lighter fractions from Tolstoi Point, St. Paul Island. In this case the density of the spines on the disk varies somewhat but, as Lohman pointed out, they do not extend outward over the border and the disks are symmetrically oval. Lohman also indicated the impossibility of assigning species of *Xanthiopyxis* to species of *Chaetoceros* as spore cases during studies of deposits of fossil material. The assumption that such objects are spores is not warranted at this time and even if it should be found to be true with some living individuals, this should have no effect whatsoever upon the use of the fossils in stratigraphy and the use of the names assigned to them. So far as is known *X. ovalis* is confined to beds of Pliocene age.

Xanthiopyxis umbonata Greville.
(Figure 87.)

Xanthiopyxis umbonata Greville, Trans. Micro. Soc. London, n.s., vol. 14, 1866, p. 2, pl. 1, fig. 5. Monterey, California. Wolle, Diat. N. Amer., 1894, pl. 74, fig. 16.

The species is rare in the collections made at the Pribilof Islands. It was originally described from upper Miocene diatomite from Monterey, California, and a study of many specimens from there failed to disclose any which have the disk so completely covered with spines as the one here illustrated. The Monterey specimens have a hyaline zone of variable width inside the border before spines appear. Nevertheless, it seems best to refer the Alaska material to that species. *Xanthiopyxis cingulatus* Ehrenberg (Hanna and Grant, 1926, p. 169, pl. 21, fig. 9) from the upper Miocene of Maria Madre Island, Mexico, has spines scattered sparsely over the entire disk but in that species a series also projects outwardly from the margin.

Silicoflagellata and Ebriata

The members of these groups have siliceous skeletons and therefore become concentrated along with diatoms, in the preparation of fossil materials. They are small in size and rare in present seas. Many of the genera are extinct. The oldest known forms are late Cretaceous in age.

Maximum development seems to have been reached in the Miocene. The two groups differ in that the Silicoflagellata are said to have hollow skeletal structures whereas these are solid in the Ebriata. Currently the first is placed in the plant kingdom and the latter in the animal kingdom, a distinction of somewhat questionable value so far as applied paleontology is concerned. Members of both groups have definite stratigraphic value. They are placed in the kingdom Protista along with Diatomaceae, Foraminifera, and other groups in the Treatise on Invertebrate Paleontology currently being published under the editorship of R. C. Moore.

Three species of Silicoflagata have been recognized in the Pribilof Island deposits and there is one Ebriata, *Ebriopsis antiqua* (Schulz).

Silicoflagellata

Since members of this group are normally present in most collections of cleaned marine, fossil diatoms, it is convenient to select representatives of the various species during the preparation of specimen slides. Some of the forms have very significant stratigraphic value. Most of the genera are extinct.

In the Pribilof Island collections only one species, *Ebriopsis antiqua* Schulz, belonging to the Ebriata was found. It apparently is confined to the Miocene and Pliocene.

Dictyocha fibula Ehrenberg.
(Figure 75.)

Dictyocha fibula Ehrenberg, Mikrog., 1854, pl. 18, figs. 54, 55; pl. 20, fig. 45. Gemeinhardt, Krypt.-Fl., vol. 10, pt. 2, Silicoflagellatae, 1930, p. 47, fig. 39.

The species occurs with *Distephanus* and *Ebriopsis* in about equal abundance in the finer fractions of preparations from nearly all of the Pribilof Island diatom-bearing deposits.

Distephanus speculum (Ehrenberg).
(Figures 71, 72.)

Dictyocha speculum Ehrenberg, Mikrog., 1854, pl. 18, figs. 5–7.
Distephanus speculum (Ehrenberg), Gemeinhardt, Rabenhorst's Kryptogamen-Flora von Deutschland, Osterreich und der Schweiz, vol. 10, pt. 2, Silicoflagellatae, 1930, p. 61, figs. 53 a–h.

The three genera of silicoflagellates are fairly common in the lighter separations of material from most of the Pribilof Island localities.

This species is somewhat more complicated than the preceding and some modern students have considered the two to belong to the same genus.

Mesocena corona Hanna, new species.
(Figure 73.)

This is a heavy circular ring with 12 strong, sharp spines. These point alternately slight upward and downward from the central horizontal plane of the ring. Diameter .036 mm.

Holotype no. 3611 (CAS), Dept. Geol. Type Coll. from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Pliocene.

This is much heavier than any other species of *Mesocena* I have seen.

Ebriopsis antiqua (Schulz), Hovasse.
(Figure 67.)

Ebria antiqua Schultz, Bot. Archiv, vol. 21, pt. 2, 1928, p. 273, fig. 69. Miocene, Japan, California, Maryland.
Ebriopsis antiqua (Schulz), Hovasse, Bull. Soc. Zool. France, vol. 57, 1932, p. 120, fig. 1. "Santa Monica." [California, Miocene.]

Usually all three genera of the common silicoflagellates are found, a few on each strewn slide, and all are present in about equal numbers.

REFERENCES

Azpeitia Moros, D. Florentino

1911. La Diatomología Española en los comienzos del Siglo XX Asociación Española para el Progreso de las Ciencias, Congreso de Zaragoza, vol. 4, Sec. 3a, Ciencias Naturales Segunda parte, Madrid, 320 pages, 12 plates.

Bailey, J. W.

1845. Notice of some new localities of Infusoria, fossil and Recent. The American Journal of Science and Arts, vol. 48, no. 2, pp. 321–343, pl. 4.

Barker, J. W., and S. H. Meakin

1949. New and rare diatoms. The Journal of the Quekett Microscopical Club, ser. 4, vol. 2, no. 6, pp. 301, pls. 37 and 38.

Barth, T. F. W.

1956. Geology and petrology of the Pribilof Islands, Alaska. Bulletin U. S. Geological Survey, no. 1028F, pp. iv, 101–160, 2 maps, figs. 17–36.

Boyer, Charles S.

1927. Synopsis of North American Diatomaceae, Part I.—Coscinodiscatae, Rhizoselenatae, Biddulphiatae, Fragilariata. Proceedings of the Academy of Natural Sciences of Philadelphia, vol. 78, Supplement, 228 pp.

Brun, Jacque et Tempère, J.

1889. Diatomées Fossiles du Japon, Espéces Marines u Nouvelles des Calcaires Argileux de Sendaï & de Yedo. Mémoires de la Société de Physique et D'Histoire Naturelle de Genève, vol. 30, no. 9, 73 pp., 9 pls.

Brun, Jacques

1891. Diatomées espèces nouvelles marines, fossiles ou pélagíques. Mémoires de la Société de Physique et D'Histoire Naturelle de Genève, vol. 31, pt. 2, no. 1, 47 pp., 12 pls.

Cleve, P. T.

1873. On diatoms from the Arctic Sea. Bihang till Kongl. Svenska Vetenskaps-Akademiens Handlingar, vol. 1, no. 13, 28 pp., 4 pls.

1894. Synopsis of the Naviculoid Diatoms, pt. 1, Kongl. Svenska Vetenskaps-Akademiens Handlingar, vol. 20, no. 2, 194 pp., 5 pls.

Dall, W. H.

1896. Report on coal and lignite of Alaska. U. S. Geological Survey, 17th Annual Report, pt. 2, pp. 763–908.

1899. The mollusk fauna of the Pribilof Islands, in the Fur Seals and Fur Seal Islands of the North Pacific Ocean, pt. 3, pp. 539–546. [The fossil species found at Black Bluff, St. Paul Island are listed and the age is given as Pliocene.]

1919. On some Tertiary fossils from the Pribilof Islands. Journal Washington Academy of Sciences, vol. 9, pp. 1–3. [A list of the mollusks found at Tolstoi Point, St. Paul Island, and Tolstoi Point, St. George Island is given.]

Dawson, G. M.

1894. Geological notes on some of the coasts and islands of Bering Sea and vicinity. Bulletin Geological Society of America, vol. 5, pp. 117–146; Pribilof Islands, pp. 130–133.

Donahue, Jesse G.

1967. Diatoms as indicators of Pleistocene climatic fluctuations in the Pacific sector of the southern ocean. Progress in Oceanography, vol. 4, (The Quaternary History of the Ocean Basins), pp. 133–140, 1 pl. 5 text figs.

Elliot, H. W.
1875. A report on the condition of affairs in the Territory of Alaska. U. S. Treasury Department, p. 70. [Also published as House Miscellaneous Document no. 83, 44th Congress, 1st Session.]
1886. Our Arctic Province, p. 229.
Grewingk, Constantine
1850. Beitrag zur Kenntniss der orgraphischen, etc., der Nordweste Küste Amerikas. Verhandlungen der Russisch Kaiserlichen Mineralogischen Gesellschaft zu St. Petersburg. [Pribilof geology, p. 190. Wossnessensky's observations].
Ehrenberg, G. C.
1838. Die Infusionsthierchen als volkommene Organismen. Leipzig 548 pp., 64 pls.
1841. Verbreitung und einflus der mikroskopischen lebens in Süd-und Nord-Amerika.
[1843.] Abhandlungen der Königlichen-Akademie der wissenschaften zu Berlin. Erster Theil, pp. 291–446, pls. 1–4. [Often referred to as "Amer." or "America"].
1844. Beiträge zur Kenntniss des Kleinsten Lebens im ägäischen Meere am Euphrat und
[1845.] auf den Bermuda-Inseln. Monatsberichten der Berliner Akademie der Wissenschaften, p. 264.
1854. Mikrogeologie. Das Erden und Felsen Schaffende Wirken des Unsichtbar Kleinen Selbstständigen Lebens auf der Erde. Leipzig, verlag von L. Voss in two parts. Text pp. I–XXVIII, 1–374; Atlas, pp. 1–31, pls. I–XXXX.
Greville, R. K.
1865. Descriptions of new and rare diatoms, series 16. Transactions of the Microscopical Society of London, new series, vol. 13, pp. 43–57, pls. 5, 6.
Hanna, G Dallas
1919. Geological notes on the Pribilof Islands, Alaska, with an account of the fossil diatoms. American Journal of Science, vol. 48, pp. 216–224.
1927. The lowest known Tertiary diatoms in California. Journal of Paleontology, vol. 1, no. 2, pp. 103–127, pls. 17–21.
1930. The growth of *Omphalotheca*. Journal of Paleontology, vol. 4, no. 2, p. 192.
Hanna, G Dallas, and W. M. Grant
1926. Miocene marine diatoms from Maria Madre Island, Mexico. Proceedings of the California Academy of Sciences, 4th ser., vol. 15, no. 2, pp. 115–192, pls. 12–21.
Hendey, N. I.
1937. The plankton diatoms of the southern seas. Discovery Reports, vol. 16, pp. 151–364, pls. 6–13.
Hopkins, David M., F. MacNeil, R. Merklin, and O. Petrov
1965. Quaternary correlations across Bering Strait. Recent Soviet and American studies cast new light on the history of the Bering Sea land bridge. Science, N.S., vol. 147, no. 3662, pp. 1107–1114, map.
Hopkins, David, and Thorleifur Einarsson
1966. Pleistocene glaciation on St. George, Pribilof Islands. Science, n.s., vol. 152, no. 3720, pp. 343–344, 2 text figs.
Hustedt, Friedrich
1930. Die Süsswasser-Flora Mitteleuropas, Heft 10 : Bacillariophyta (Diatomeae), 466 pages, 875 text figures.
Jousé, A. P.
1959. The main phases in the development of the flora of marine diatoms in the far eastern seas of the USSR at the end of the Tertiary and during the Quaternary period. Academy of Sciences, USSR. Botanical Journal, vol. 44, no. 1, pp. 44–55, pls. 2–4.

1961. Diatomeae Marinae Mioceni et Pliocenei ex Oriente Extremo. Akademiia Nauk SSSR. Lenigrad. Botanichesii Institut. Otdel Sporovykh Rastinii Botanicheskie Materialy, vol. 14, pp. 59–70, 3 pls.

Junk, Wilhelm

1900–1913. Rara historica-naturalia et mathematica, Berlin; vol. 1, 121 pp., vol. 2, 1926–1936, pp. 123–240.

Kanaya, Taro, and Itaru Koizumi

1966. Interpretation of Diatom Thanatocoenoses from the North Pacific applied to a study of core V 20-130 (Studies of a Deep-sea Core V 20-130, Part IV.) Science Reports, Tohoku University, Sendai, ser. 2, (Geol.), vol. 37, no. 2, pp. 89–130, 6 text figs.

Mann, Albert

1925. Marine diatoms of the Philippine Islands. Bulletin of the U. S. National Museum no. 100, vol. 6, pt. 1, 182 pp., 39 pls.

Mills, F. W.

1933–1935. An index to the genera and species of the Diatomaceae and their synonyms, 21 parts, 1726 pages. Wheldon & Wesley, Ltd. London.

Muir, John

1883. Arctic Cruise of the Revenue Cutter *Corwin* in 1881, p. 140. [Notes and observations on supposed general glaciation of the Pribilofs.]

Schmidt, A., and others

1874–1959. Atlas der Diatomaceenkunde, 480 plates.

Scholl, David W., Edwin G. Buffington, and David M. Hopkins

1966. Exposure of basement rock on the continental slope of the Bering Sea. Science, n.s., vol. 153, August 26, pp. 992–994, 3 text figures.

Sheshukova-Poretskaia, V. S.

1967. Neogene marine diatoms of Sakhalin and Kamchatka. 432 pp., 50 pls. Leningrad University Press.

Smith, W.

1853. A synopsis of the British Diatomaceae; with remarks on their structure, functions and distribution; and instructions for collecting and preserving specimens, vol. 1, pp. I–XXXIII, 1–92, pls. 1–31. London.

Stanley-Brown, J.

1892. Geology of the Pribilof Islands. Bulletin, Geological Society of America, vol. 3, pp. 496–500.

Van Heurck, Henri

1880–1883. Synopsis des Diatomées de Belgique, Anvers, Atlas, 141 plates, 2 pages introduction, 6 pages index.

Washington, H. S.

1930. Rocks on the Pribilof Islands. American Journal of Science, vol. 20, pp. 321–338.

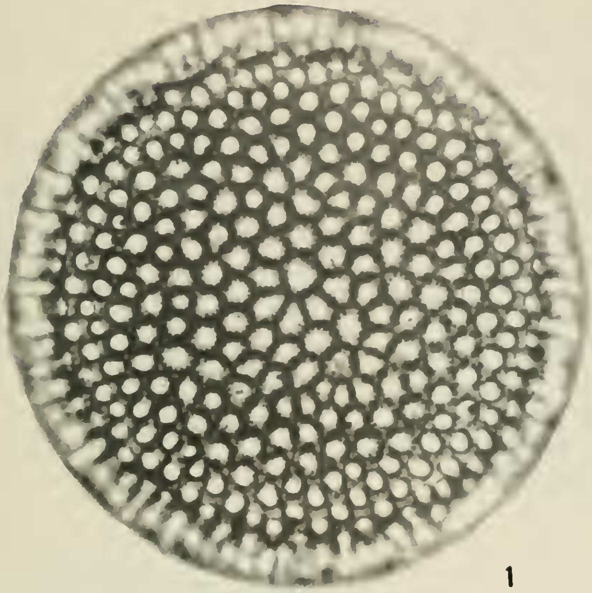
Zabelina, M.

1934. Trudy Neftianogo Geologo-Razvedochnogo Institute Ser. A, no. 48, pp. 1–19, 9 test figs. [Diatoms from the Tertiary deposits of the eastern coast of Kamchatka. Transactions of the Petroleum Prospecting Institute Ser. A, No. 48, pp. 1–19, 9 text figs.] [State Scientific-Technical Mining-Geological-Petroleum Publishing House, Leningrad, Moscow, Novosibirsk, 1934.]

Figure 1. *Coscinodiscus marginatus* Ehrenberg. Hypotype no. 3578 (Calif. Acad. Sci., Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .0870 mm.

Figure 2. *Coscinodiscus marginatus* Ehrenberg. Hypotype no. 3579 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 1. Diameter .200 mm.

Figure 3. *Coscinodiscus undulosus* Mann. Hypotype no. 3580 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 1. Diameter .0860 mm.



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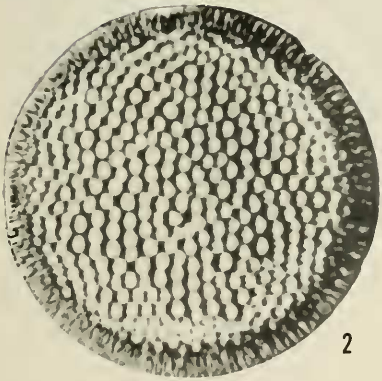

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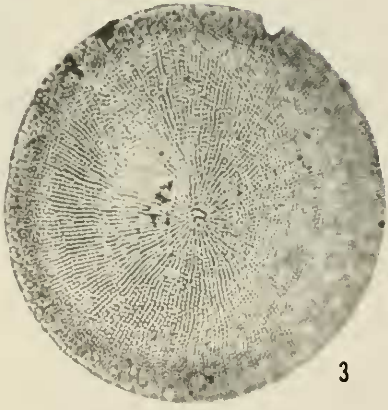

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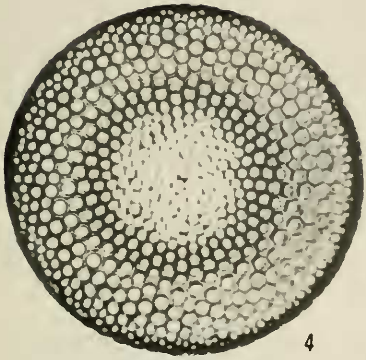
Figure 4. *Coscinodiscus radiatus* Ehrenberg. Hypotype no. 3581 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .1490 mm.

Figure 5. *Thalassiosira punctata* Jousé. Hypotype no. 3582 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 1233 (CAS), Black Bluff, St. Paul Island, Alaska. Diameter .0456 mm.

Figure 6. *Thalassiosira punctata* Jousé. Hypotype no. 3583 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 1. Diameter .0570 mm.

Figure 7. *Coscinodiscus kützingii* Schmidt. Hypotype no. 3584 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 717 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .0506 mm.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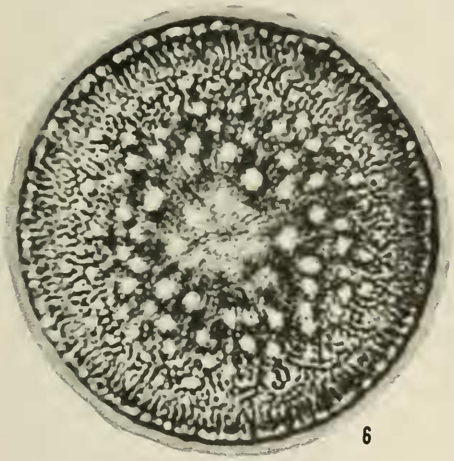
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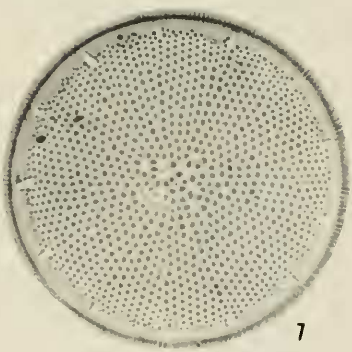
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Figure 8. *Coscinodiscus radiatus* Ehrenberg. Hypotype no. 3593 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 1322 (CAS), St. Paul Island, Alaska, Navy Well no. 2, depth 90 feet. Diameter .1156 mm.

Figure 9. *Cosmiodiscus insignis* Jousé. Hypotype no. 3594 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 1322 (CAS), St. Paul Island, Alaska, Navy Well no. 2, depth 400 feet. Diameter .0640 mm.

Figure 10. *Cosmiodiscus insignis* Jousé. Hypotype no. 3595 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 9. Diameter .0660 mm.

Figure 11. *Cosmiodiscus insignis* Jousé. Hypotype no. 3595A (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 9. Diameter .0726 mm.

Figure 12. *Coscinodiscus pustulatus* Mann. Hypotype no. 3596 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .0416 mm.

Figure 13. *Diploneis ornatus* Schmidt. Hypotype no. 3597 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 12. Diameter .0510 mm.

Figure 14. *Diploneis bombus* (Ehrenberg). Hypotype no. 3598 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 8. Length .060 mm.

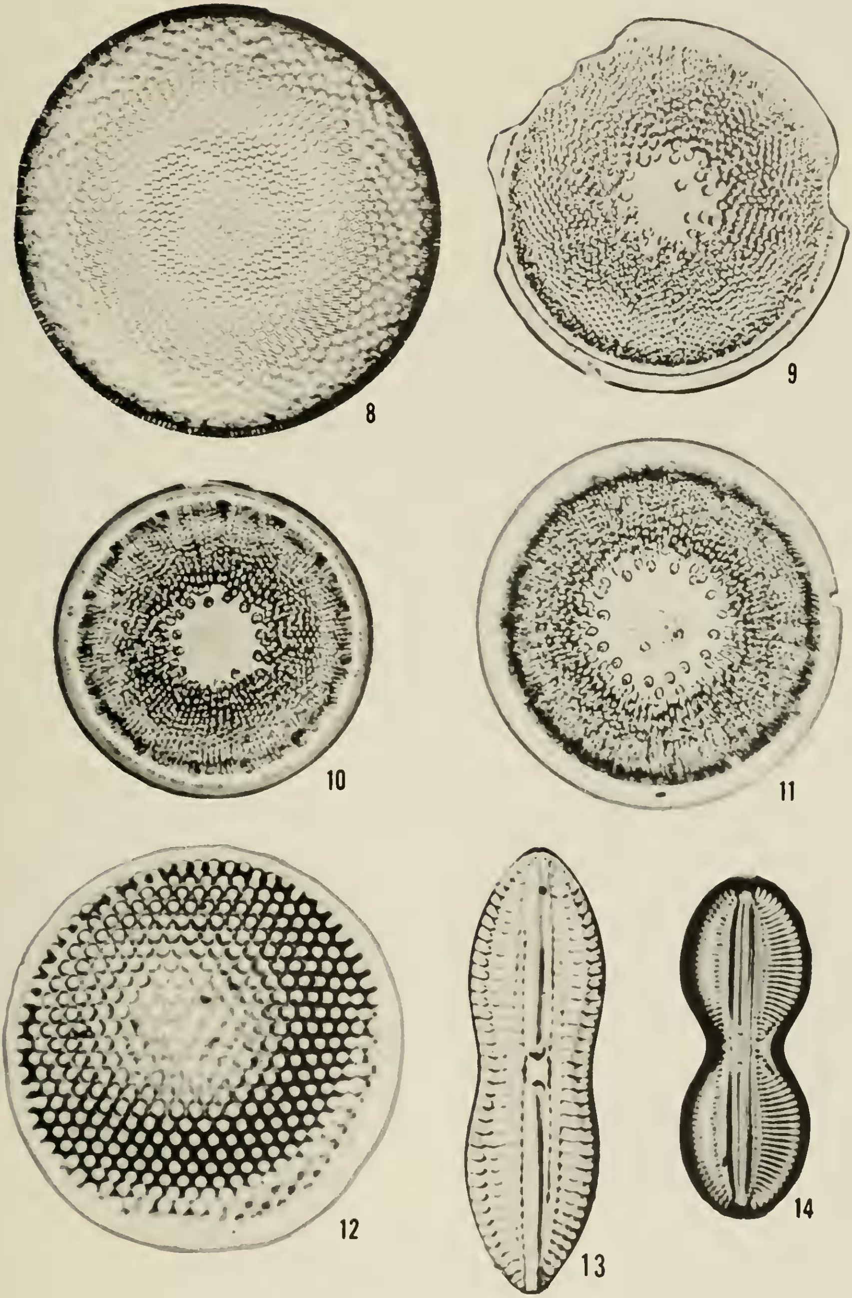

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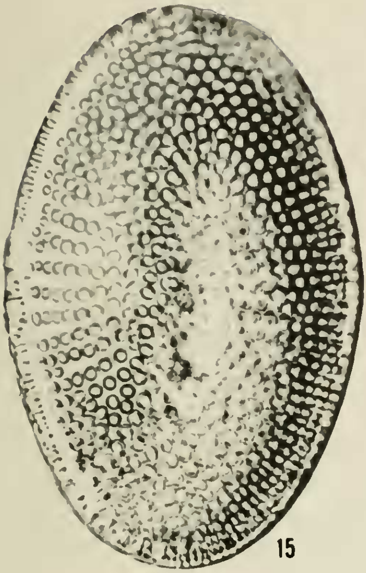
Figure 15. *Cymatotheca weissflogii* (Grunow), Hendey. Hypotype no. 3586 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Length .0860 mm., width .0768 mm.

Figure 16. *Cymatotheca weissflogii* (Grunow), Hendey. Hypotype no. 3587 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 1233 (CAS), Black Bluff, St. Paul Island, Alaska. Length .040 mm., width .0344 mm.

Figure 17. *Coscinodiscus radiatus* Ehrenberg. Hypotype no. 3588 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 1322 (CAS), St. Paul Island, Alaska, Navy Well no. 2, depth 90 feet. Diameter .1332 mm.

Figure 18. *Coscinodiscus oculus-iridus* Ehrenberg. Hypotype no. 3589 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 15. Diameter .240 mm.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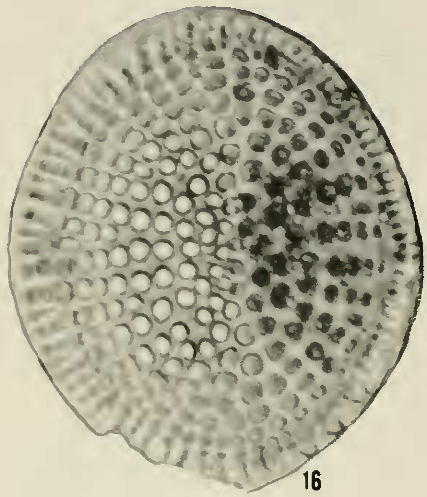
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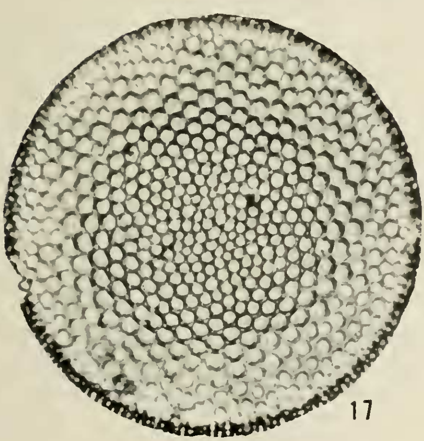
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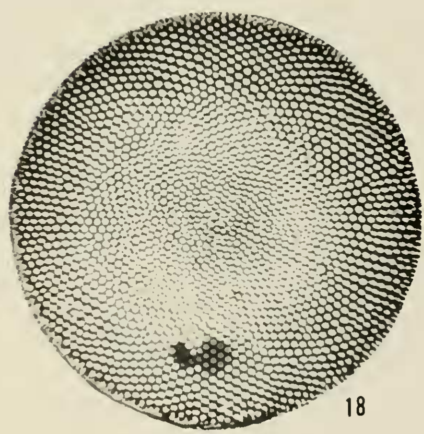
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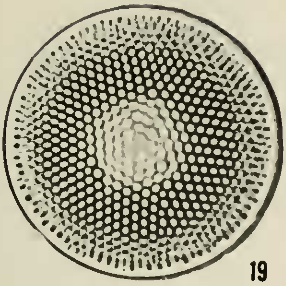
Figure 19. *Coscinodiscus pustulatus* Mann. Hypotype no. 3599 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 717 (CAS), Tolstoi Point, St. Paul Island. Alaska. Diameter .0526 mm.

Figure 20. *Coscinodiscus pustulatus* Mann. Hypotype no. 3600 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 21. Diameter .0356 mm.

Figures 21, 22. *Coscinodiscus pustulatus* Mann. Hypotypes nos. 3601, 3602 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .0940 and .0656 mm.

Figure 23. *Coscinodiscus pustulatus* Mann. Hypotype no. 3603 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figures 21, 22. Diameter .060 mm.

Figure 24. *Coscinodiscus pustulatus* Mann. Hypotype no. 3603A (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figures 21, 22.



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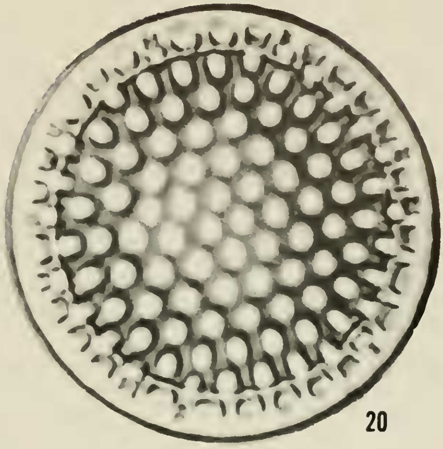

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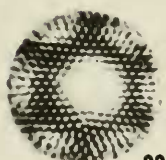

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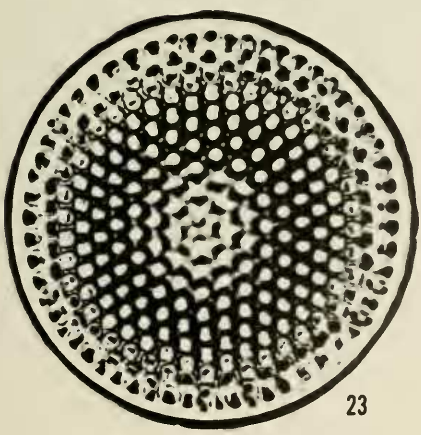

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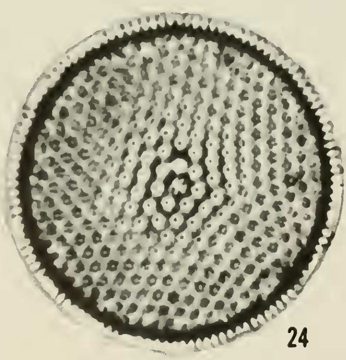

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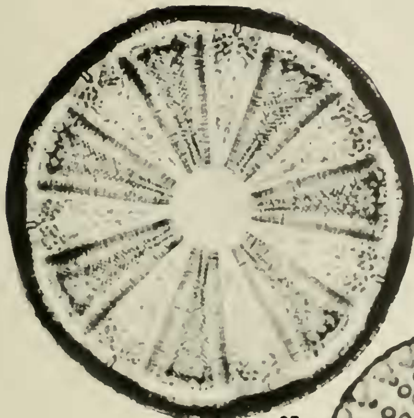
Figure 25. *Actinoptychus splendens* (Shadbolt). Hypotype no. 3549 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .0864 mm.

Figure 26. *Actinoptychus splendens* (Shadbolt). Hypotype no. 3550 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 25. Diameter .0892 mm.

Figure 27. *Rhaphoneis nitida* Gregory. Hypotype no. 3577 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 25. Length .0360 mm.

Figure 28. *Actinoptychus splendens* (Shadbolt). [= *Debya.*] Hypotype no. 3551 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 25. Diameter .0824 mm.

Figure 29. *Rhaphoneis amphiceros* Ehrenberg. Hypotype no. 3621 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 25. Length .1024 mm.



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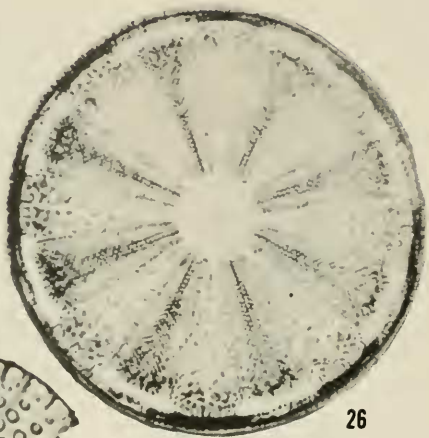

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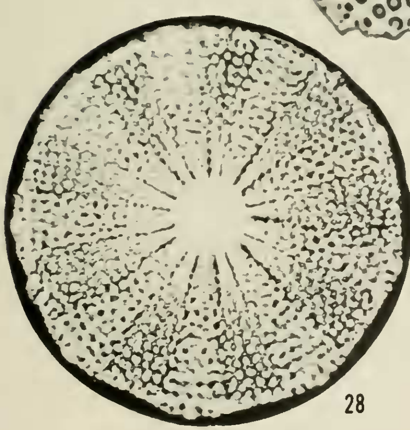

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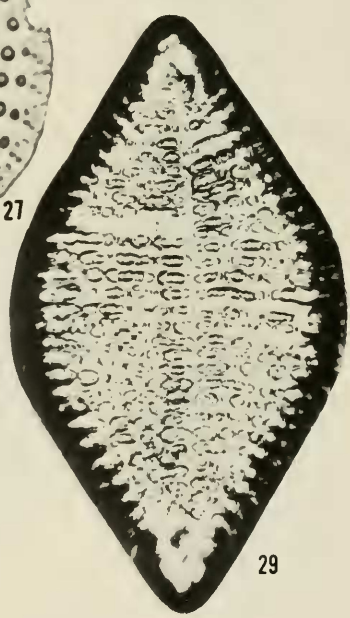

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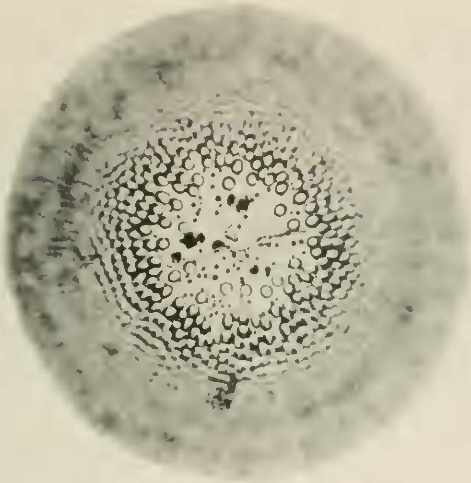
Figure 30. *Cosmiodiscus insignis* Jousé. Hypotype no. 3585 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 717 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .0476 mm.

Figure 31. *Cocconeis maxima* (Grunow). Hypotype no. 3590 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 1322(CAS), St. Paul Island, Alaska. Navy Well no. 2, depth 90 feet. Length .0360 mm.

Figure 32. *Cosmiodiscus insignis* Jousé. Same specimen as figure 30, but with a lower focus.

Figure 33. *Pinnularia lata* (Brébisson). Hypotype no. 3591 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 31. Length .0728 mm.

Figure 34. *Cocconeis pribilofensis* Hanna, new species. Hypotype no. 3574 (CAS), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Length .0302 mm.



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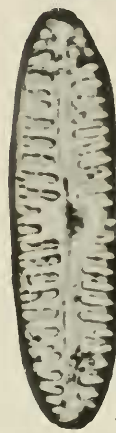

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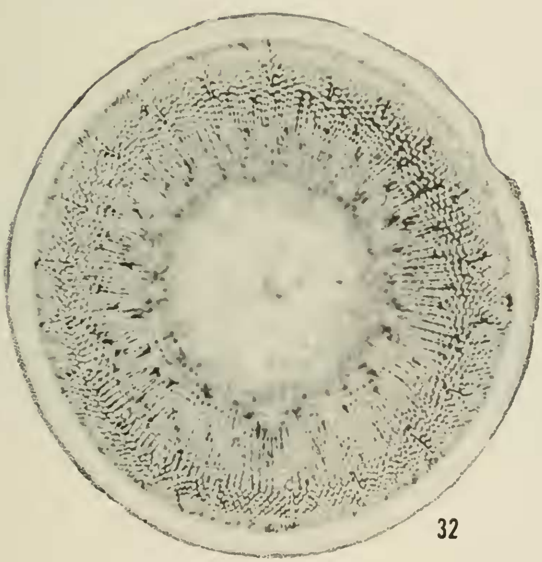

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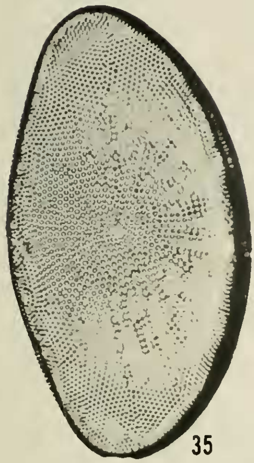
Figure 35. *Hemidiscus cuneiformis* Wallich. Hypotype no. 3556, (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Greater diameter .0900 mm.; lesser diameter .0472 mm.

Figure 36. *Coscinodiscus rothii* (Ehrenberg). Hypotype no. 3629 (Calif. Acad. Sci. Dept. Geol. Type Coll.) from same locality as figure 35. Diameter .0744 mm.

Figure 37. *Thalassionema nitzschoides* (Grunow). Hypotype no. 3572 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 35. Length .0620 mm.

Figure 38. *Actinoptychus senarius* Ehrenberg. Hypotype no. 3571 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 35. Diameter .1150.

Figure 39. *Actinoptychus senarius* Ehrenberg. Hypotype no. 3552 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 35. Diameter .1140 mm.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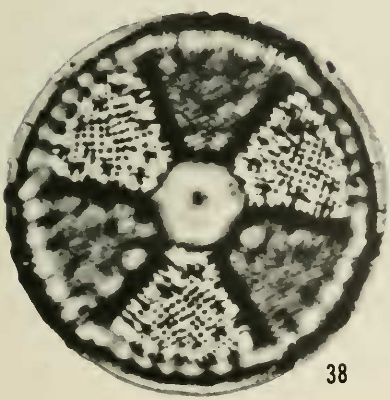
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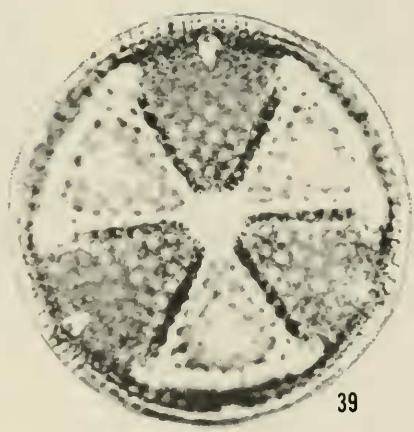
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Figure 40. *Actinoptychus splendens* (Shadbolt). Hypotype no. 3547 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .0734 mm.

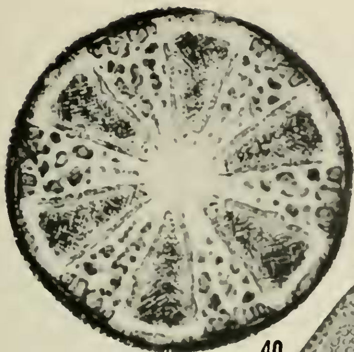
Figure 41. *Arachnoidiscus ehrenbergii* Bailey. Hypotype no. 3616 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 1322 (CAS), Navy Well no. 2, St. Paul Island, Alaska. Diameter .1828 mm.

Figure 42. *Triceratium condecorum* Brightwell. Hypotype no. 3618 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 40. Length of base to apex .0852 mm.

Figure 43. *Triceratium montereyi* Brightwell. Hypotype no. 3619 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 40. Length of one side .1154 mm.

Figure 44. *Actinoptychus splendens* (Shadbolt). Hypotype no. 3548 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 40. Diameter .1068 mm.

Figure 45. *Actinoptychus senarius* Ehrenberg. Hypotype no. 3553 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 40. Diameter .0682 mm.



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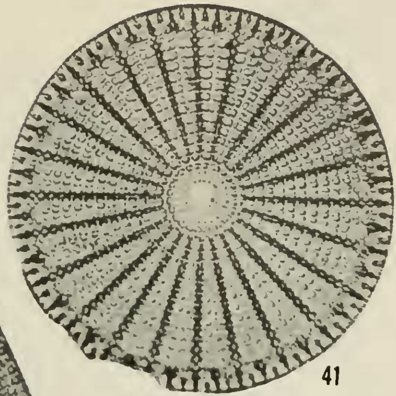

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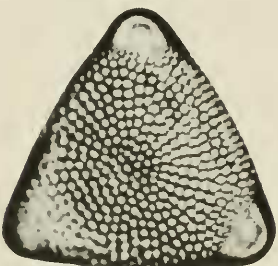

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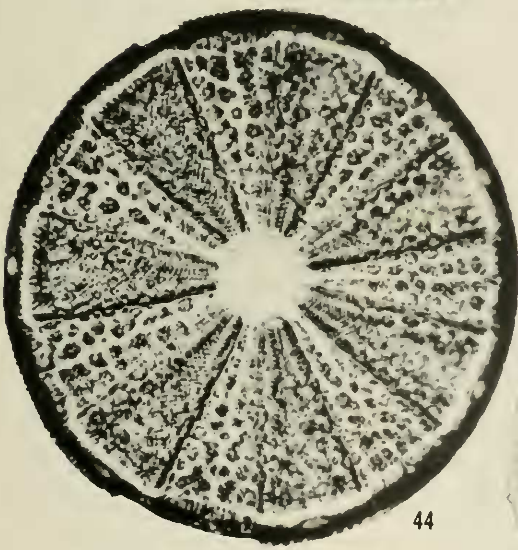

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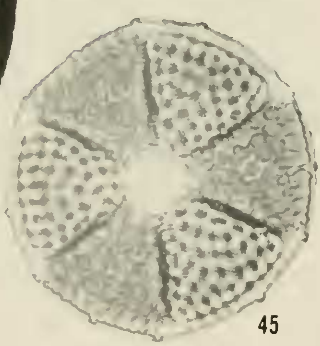

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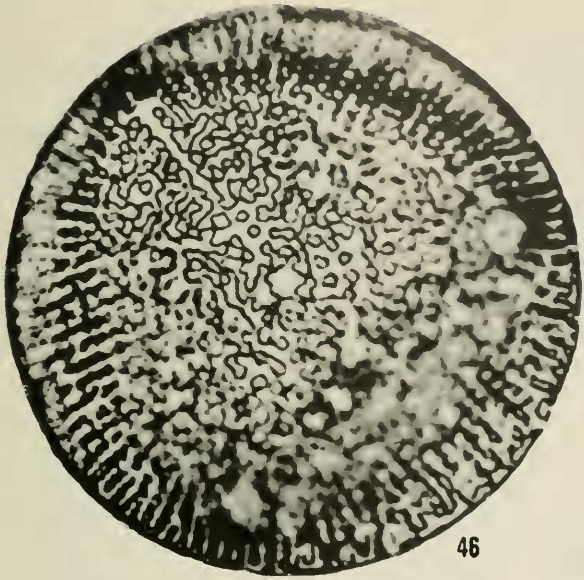
Figure 46. *Aulacodiscus tripartitus* Tempère and Brun. Hypotype no. 3575 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .060 mm.

Figure 47. *Rhabdonema japonicum* Tempère and Brun. Hypotype no. 3576 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 46. Length .0760 mm.

Figure 48. *Cocconeis antiqua* Tempère and Brun. Hypotype no. 3573 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 46. Length .0950 mm.

Figure 49. *Aulacodiscus tripartitus* Tempère and Brun. Hypotype no. 3637 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 46. Diameter .0732 mm.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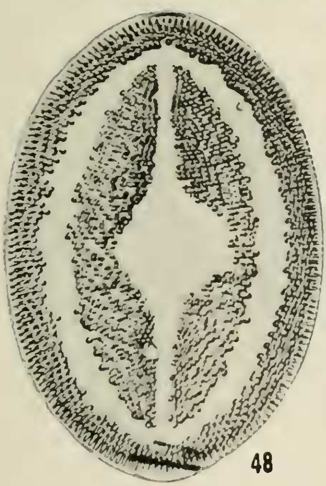
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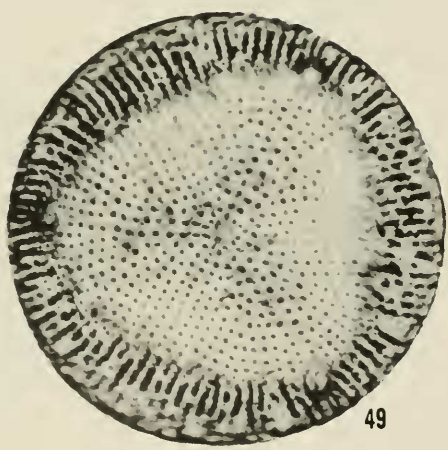
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Figure 50. *Melosira sulcata* (Ehrenberg). Hypotype no. 3604 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 38579 (CAS), Einahnuhto Bluffs, St. Paul Island, Alaska. Diameter .0350 mm.

Figure 51. *Melosira sulcata* (Ehrenberg). Hypotype no. 3605 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .0426 mm.

Figure 52. *Melosira clavigera* Grunow. Hypotype no. 3555 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 51. Diameter .0888 mm.

Figure 53. *Melosira sulcata* (Ehrenberg). Hypotype no. 3606 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 51. Diameter .0256 mm.

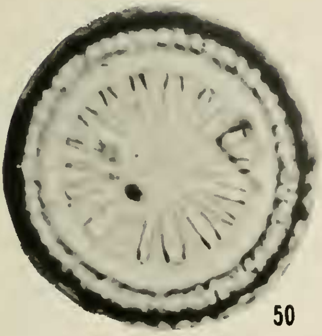
Figure 54. *Melosira clavigera* Grunow. Hypotype no .3604 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 51. Diameter .0270 mm.

Figure 55. *Rhaphoneis amphiceros* (Ehrenberg). Hypotype no. 3607 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 51. Length .0320 mm.

Figure 56. *Rhaphoneis amphiceros* (Ehrenberg). Hypotype no. 3607A (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 51. Length .0306 mm.

Figure 57. *Rhaphoneis lancettula* Grunow *in* Pantocsek. Hypotype no. 3617 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 51. Length .1420 mm.

Figure 58. *Stephanopyxis appendiculata* Ehrenberg. Hypotype no. 3610 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 1322 (CAS), Navy Well no. 2, St. Paul Island, Alaska. Depth, 90 feet. Diameter .0284 mm.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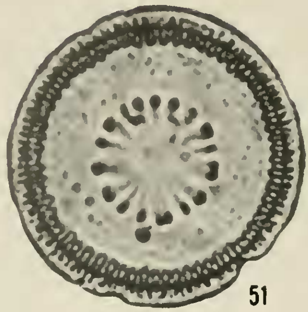
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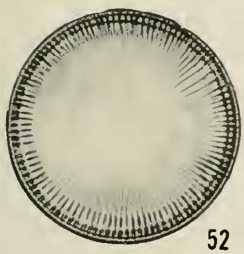
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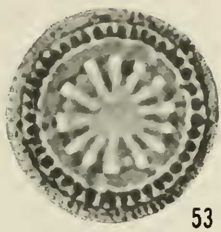
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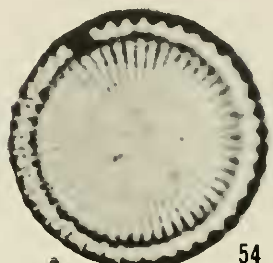
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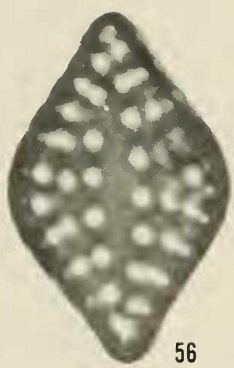
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Figure 59. *Dossetia temperei* Azpeitia. Hypotype no. 3625 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Length of base .0568 mm.

Figure 60. *Dossetia temperei* Azpeitia. Hypotype no. 3625A (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Greatest diameter .0560 mm.

Figure 61. *Pyxilla americana* Grunow. Hypotype no. 3626 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Length .0948 mm.

Figure 62. *Chaetoceros didymus* Ehrenberg. Hypotype no. 3620 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Length .0572 mm.

Figure 63. *Dicladia capreola* Ehrenberg. Hypotype no. 3622 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Length of base .0332 mm.

Figure 64. *Xanthiopyxis ovalis* Lohman. Hypotype no. 3608A (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Length .0280 mm.

Figure 65. *Chaetoceras ?* (sp.). Hypotype no. 3627 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Length .0320 mm.

Figure 66. *Pseudopyxilla dubia* (Grunow) Forti. Hypotype no. 3623 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Length .1092 mm.

Figure 67. *Ebriopsis antiqua* (Schulz), Hovasse. Hypotype no. 3612 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Diameter .0270 mm.

Figure 68. *Pseudopyxilla dubia* (Grunow), Forti. Hypotype no. 3624 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Diameter .0568 mm.

Figure 69. *Xanthiopyxis lohmani* Hanna, new species. Holotype no. 3608 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Length .0448 mm.

Figure 70. *Xanthiopyxis ovalis* Lohman. Hypotype no. 3609 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Length .0306 mm.

Figure 71. *Distephanus speculum* Ehrenberg. Hypotype no. 3613 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Diameter, exclusive of spines, .0228 mm.

Figure 72. *Distephanus speculum* Ehrenberg. Hypotype no. 3614 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Diameter .0244 mm.

Figure 73. *Mesocena corona* Hanna, new species. Holotype no. 3611 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Diameter .0340 mm., exclusive of spines.

Figure 74. *Xanthiopyxis globosa* Ehrenberg. Hyptoype no. 3592 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Diameter of base .0256 mm,

Figure 75. *Dictyocha fibula* Ehrenberg. Hypotype no. 3615 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from same locality as figure 59. Horizontal length .0280 mm., exclusive of spines.

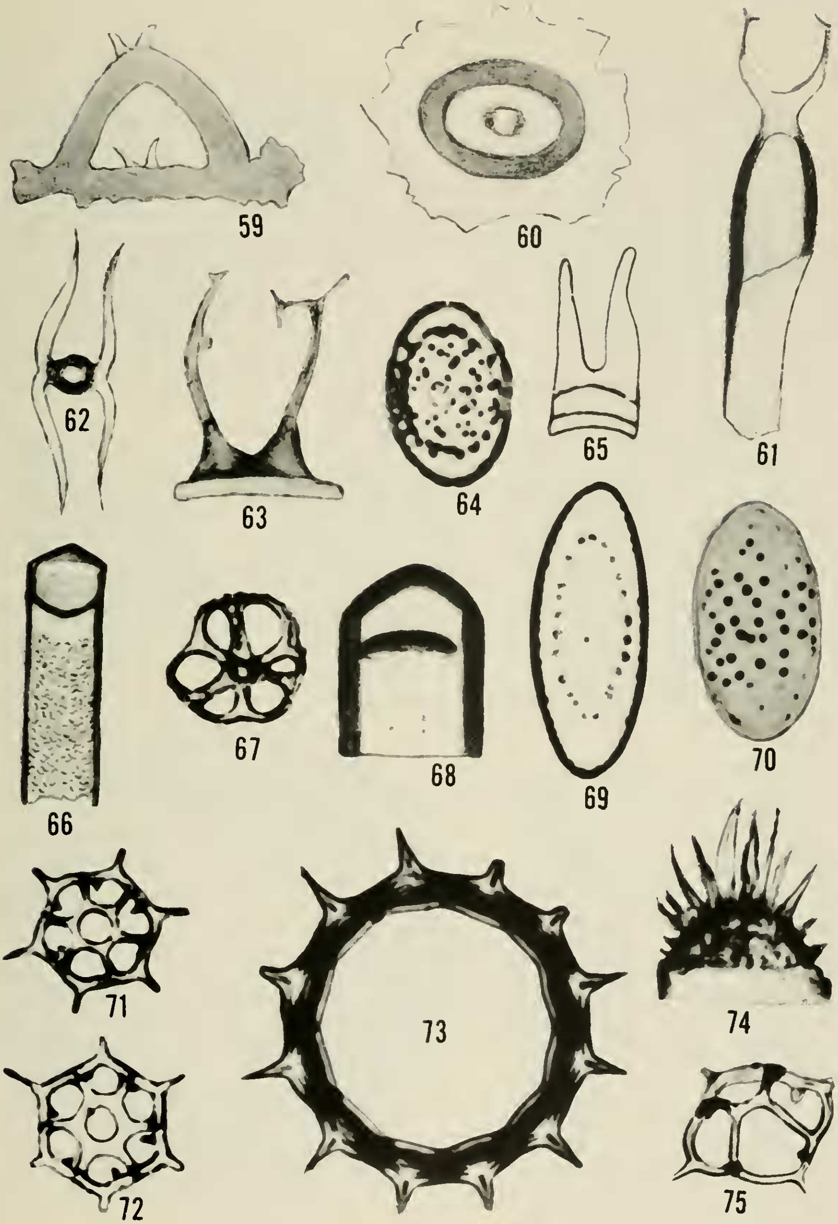
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Figure 76. *Actinoptychus senarius* Ehrenberg. Hypotype no. 3631 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .0928 mm.

Figure 77. *Arachnoidiscus indicus* Ehrenberg. Hypotype no. 3635 (CAS), from same locality as figure 76. Diameter .0644 mm.

Figure 78. *Biddulphia aurita* (Lyngbye) Brébisson and Godey. Hypotype no. 3656B (CAS), from same locality as figure 76. Diameter .0540 mm.

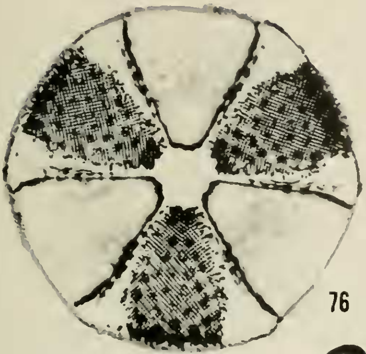
Figure 79. *Biddulphia roperiana* Greville. Hypotype no. 3638 (CAS), from same locality as figure 76. Length .0748 mm.

Figure 80. *Arachnoidiscus indicus* Ehrenberg. Hypotype no. 3634 (CAS), from same locality as figure 76. Diameter .0692 mm.

Figure 81. *Coscinodiscus fimbriatus* Ehrenberg. Hypotype no. 3641 (CAS), from same locality as figure 76. Diameter .1088 mm.

Figure 82. *Biddulphia baltzoi* Hanna, new species. Hypotype no. 3639 (CAS), from same locality as figure 76. Length .040 mm.

Figure 83. *Rhaphoneis rhombus* Ehrenberg. Hypotype no. 3651 (CAS), from same locality as figure 76. Length .0564 mm.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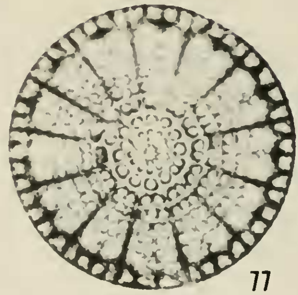
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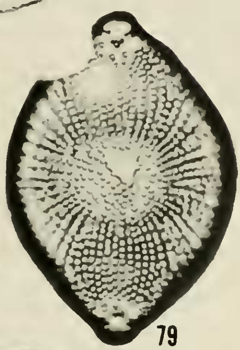
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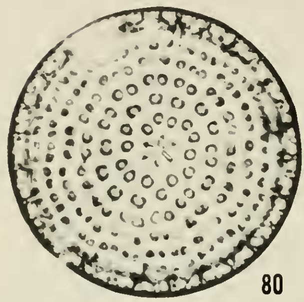
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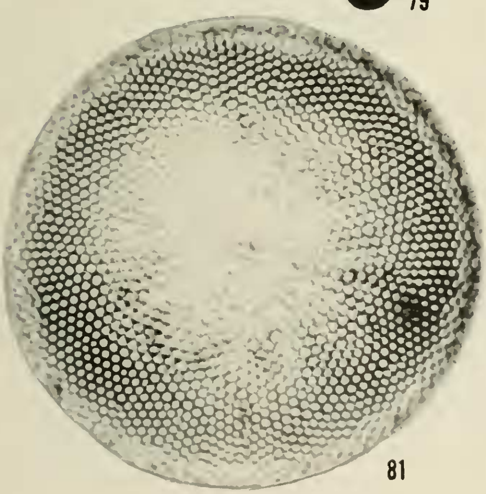
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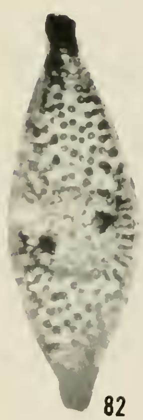
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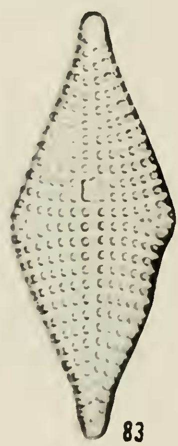
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Figure 84. *Hercotheca inermis* Mann. Hypotype no. 3648 (CAS), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Length .0372 mm.

Figure 85. *Triceratium validum* Grunow. Hypotype no. 3655 (CAS), from same locality as figure 84. Height .1040 mm.

Figure 86. *Hemidiscus rotundus* Janisch. Hypotype no. 3646 (CAS), from same locality as figure 84. Length .0944 mm., width .0816 mm.

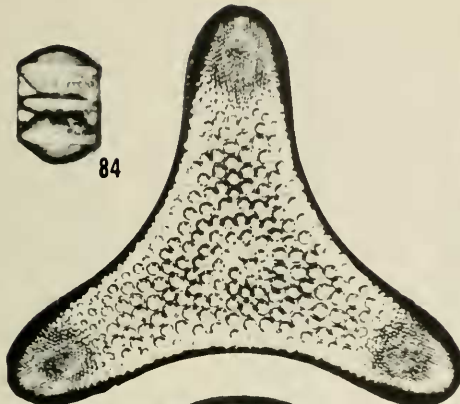
Figure 87. *Xanthiopyxis umbonatus* Greville. Hypotype no. 3656 (CAS), from same locality as figure 84. Diameter .1104 mm.

Figure 88. *Triceratium condecorum* Brightwell. Hypotype no. 3654 (CAS), from same locality as figure 84. Height .0420 mm.

Figure 89. *Cocconeis formosa* Brun. Hypotype no. 3640 (CAS), from same locality as figure 84. Length .0376 mm.

Figure 90. *Asterolampra darwinii* Greville. Hypotype no. 3636 (CAS), from same locality as figure 84. Diameter .0560 mm.

Figure 91. *Lithodesmium undulatum* Ehrenberg. Hypotype no. 3653 (CAS), from same locality as figure 84. Height .030 mm.



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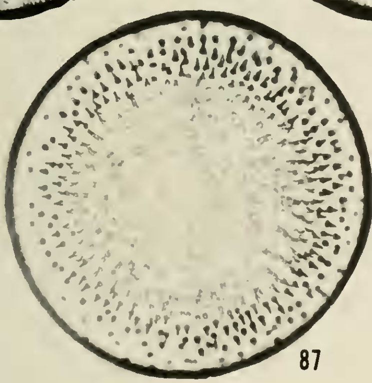

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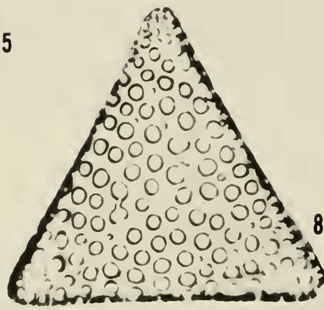

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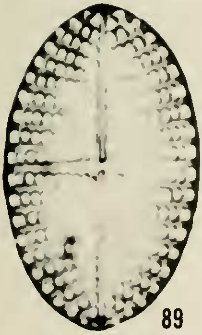

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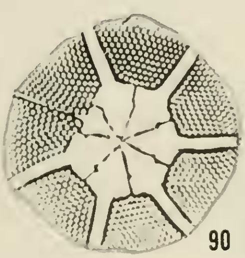

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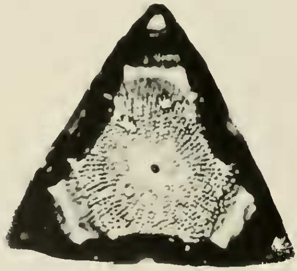

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Figure 92. *Rhabdonema japonicum* Tempère and Brun. Hypotype no. 3643 (CAS), from locality no. 36928 (CAS), Tolstoi Point, St. Paul Island, Alaska. Length .1460 mm.

Figure 93. *Rhabdonema japonicum* Tempère and Brun. Hypotype no. 3644 (CAS), from same locality as figure 92. Length .1892 mm.

Figure 94. *Rhabdonema crozieri* (Ehrenberg). Hypotype no. 3645 (CAS), from same locality as figure 92. Length .0812 mm.

Figure 95. *Rhabdonema japonicum* Tempère and Brun. Hypotype no. 3642 (CAS), from same locality as figure 92. Length .1280 mm.

Figure 96. *Navicula semen* Ehrenberg. Hypotype no. 3649 (CAS), from same locality as figure 92. Length .0832 mm.

Figure 97. *Chaetoceros didymus* Ehrenberg. Hypotype no. 3632 (CAS), from same locality as figure 92. Length .1440 mm.

Figure 98. *Chaetoceros didymus* Ehrenberg. Hypotype no. 3630 (CAS), from locality no. 1322 (CAS), Navy Well no. 2, St. Paul Island, Alaska. Length .0656 mm.

Figure 99. *Stephanopyxis appendiculata* Ehrenberg. Hypotype no. 3652 (CAS), from same locality as figure 92. Diameter .0508 mm.

Figure 100. *Stephanopyxis appendiculata* Ehrenberg. Hypotype no. 3652A (CAS), from same locality as figure 92. Diameter .0548 mm.

Figure 101. *Pinnularia ruttneri* Hustedt in Schmidt. Hypotype no. 3650 (CAS), from same locality as figure 92. Length .120 mm.


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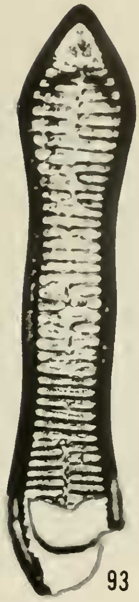
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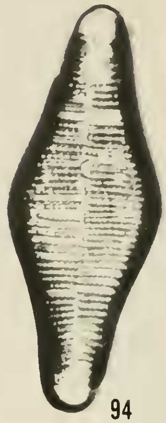
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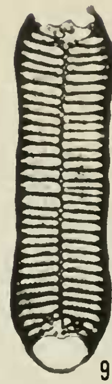
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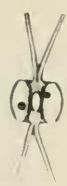
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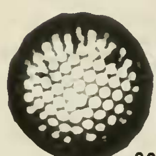
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Figure 102. *Aulacodiscus laxus* (Mann). Hypotype no. 3950 (CAS), from locality no. 36829 (CAS), Tolstoi Point, St. Paul Island, Alaska. Diameter .084 mm.

Figure 103. *Aulacodiscus tripartitus* Tempère and Brun. Hypotype no. 3951 (CAS), from same locality as figure 102. Diameter .080 mm.

Figure 104. *Aulacodiscus laxus* (Mann). Hypotype no. 3952 (CAS), from same locality as figure 102. Diameter .093 mm.

Figure 105. *Aulacodiscus tripartitus* Tempère and Brun. Hypotype no. 3953 (CAS), from same locality as figure 102. Diameter .074 mm.

Figures 102–105 are from photographs made by Dr. A. L. Brigger, Research Associate, California Academy of Sciences.

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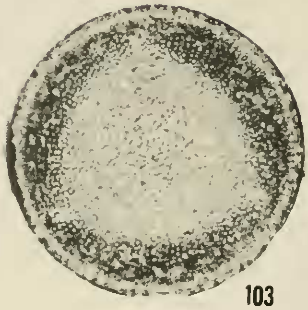

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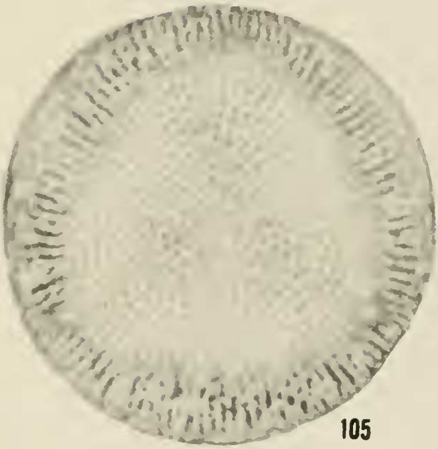

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